Farnell

INCORPORATING WAYNE KERR INSTRUMENTS

Racal Mobilcal Ltd.
Test Equipment Maintenance Department
Location:- D1
ID 1173

Instruction/Service Manual
for

Bench Power Supply

PSD3510A

MP MASTER
MA23427

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Bench Power Supply

PSD3510A

Single Output Digitally Metered Power Supply
350 Watt Output Power @ 35V & 10A
With Remote Programming

HANDBOOK
Part N° 9HPSD3510A

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SAFETY

GENERAL

This equipment has been designed to meet the requirements of IEC publication 348, "Safety Requirements for Electronic Measuring Apparatus", and has left the factory in a safe condition.

The remainder of this section on safety provides information and warnings which must be followed by the user to ensure safe operation and maintain the equipment in a safe condition.

A.C. POWER SUPPLY

1) If it is necessary to fit a suitable a.c. power plug to the power cable, the user must observe the following colour codes:

LIVE terminal to BROWN lead
NEUTRAL terminal to BLUE lead
EARTH terminal to GREEN/YELLOW lead.

The user must also ensure that the protective earth lead would be the last to break should the cable be subject to excessive strain.

2) If the power cable electrical connection to the a.c. power plug is through screw terminals then, to ensure reliable connections, any solder tinning of the cable wires must be removed before fitting the plug.

3) WARNING! Any interruption of the protective earth conductor inside or outside the equipment or disconnection of the protective earth terminal is likely to make the equipment dangerous. Intentional interruption is prohibited.

4) Before switching on the equipment, ensure that it is set to the voltage of the local a.c. power supply.

ADJUSTMENT, REPLACEMENT OF PARTS, MAINTENANCE AND REPAIR

1) When the equipment is connected to the local a.c. power supply internal terminals may be live and the opening of the covers or removal of parts (except those to which access can be gained by hand) is likely to expose live parts. The equipment must be disconnected from all voltage sources before it is opened for any adjustments, replacement maintenance or repair.

2) Capacitors inside the equipment may still be charged even if the equipment has been disconnected from all voltage sources.

3) Any adjustment, maintenance and repair of the opened equipment under voltage must be carried out by a skilled person who is aware of the hazards involved.

4) Ensure that only fuses with the required rated current and of the specified type are used for replacement. The use of makeshift fuses and short circuiting of fuse holders is prohibited.

STATIC ELECTRICITY

The unit supplied may use static devices and service personnel should be alerted to components which require handling precautions to avoid damage by static electrical discharge.

Before handling circuit board assemblies containing these components, personnel should observe the following precautions:

1) The work surface should be a conductive grounded mat.

2) Soldering irons must be grounded and tools must be in contact with a conductive surface to ground when not in use.

3) Any person handling static sensitive parts must wear a wrist strap which provides a leaky path to ground, impedance not greater than 1 megaohm.

4) Components or circuit board assemblies must be stored in or on conductive foam or mat while work is in progress.

5) New components should be kept in the suppliers packaging until required for use.

DISPOSAL HAZARDS

Service personnel should be aware of the following:

1) Cathode ray tubes can implode if subject to excessive mechanical shock.

2) Batteries should be disposed of intact and never incinerated.

3) Beryllium oxide washers must be disposed of intact as toxic waste.

4) Many components contain polymers which will give rise to toxic fumes if incinerated.

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1. SCHEDULE OF EQUIPMENT

The Power Supply has been carefully packed to prevent damage in transit.

The complete equipment comprises:-

Description	Part N°	Quantity
PSD3510A Power Supply.	11PSD3510A	1
IEC Mains Lead.	HC22V2	1
Shorting Links.	7SU0002	2
Handbook.	9HPSD3510A	1
Spare fuses.	FF12A010 FT4A00S503	4 2

Note: In the event of damage in transit or shortage in delivery, separate notices in writing should be given to both the carriers and Farnell Instruments Limited, within three days of receipt of the goods, followed by a complete claim within five days. All goods which are subject of any claim for damage in transit of shortage in delivery should be preserved intact as delivered for a period of seven days after making the claim, pending inspection or instructions from Farnell Instruments or an agent of this company.

2. INTRODUCTION

The Farnell PSD3510A is a single output power supply with an output range of 0 to 35V and 0 to 10A. Other features include:

* Simultaneous monitoring of voltage, current and power with a custom LCD.
* Ten turn voltage and current potentiometers for accurate setting.
* Resistive or voltage programming via back panel terminal block.
* Remote sense that will compensate for up to 0.5V drop along load leads.
* Twin speed fan for quiet normal operation.
* Over temperature protection.
* Mains high and mains low detection circuit disables output.
* Programmable over voltage crowbar provided with viewable set level.

3. SPECIFICATION

3.1 MAINS INPUT

Voltages: 220V or 240V ±10%. 950VA maximum.
110 or 130V ±10%. 1000VA maximum. *(Made to special order)*

Frequency: 50/60Hz ±10%.

Range Change: Position of fuse drawer on IEC mains connector socket.

Connection: Via IEC lead 2.0 metres long (supplied).

3.2 OUTPUT

Single output 0-35V and up to 10.0 amps.

Output Switch

The output has an ON/OFF switch. With the switch in its OFF state, the meter displays the prospective volts and amps settings. The presence of the 'Preview' legend and the absense of either the 'CV' or 'CI' legends indicate that the output is OFF.

Output Terminals

4 mm binding posts providing the output terminals, sense terminals and safety earth. Shorting links are provided to connect sense and output.

Remote Sense

Compensates for up to 0.5V drop per load lead.

Line Regulation

CV - Less than 0.01% + 2mV for 10% line voltage change from nominal.
CI - Less than 0.01% + 200μA for 10% line voltage change from nominal.

Load Regulation

CV - Less than 0.01% + 2mV for zero to full load change.
CI - Less than 0.1% + 2mA for zero to 35V output.

Output Ripple and Noise

CV mode: (@ Full load maximum voltage.)

RMS Ripple		Pk-Pk Ripple	
Maximum	Typical	Maximum	Typical
500μV	300μV	2.5mV	1.0mV

NOTE : Ripple can be improved significantly with a small X-type capacitor to ground.

CI mode: (@ Full load maximum voltage.)

RMS Ripple		Pk-Pk Ripple	
Maximum	Typical	Maximum	Typical
1mA	800μA	3mA	2mA

Temperature Coefficient of Output Voltage
0.02% per °C

Controls
Volts control 0.02% resolution. 10 turn.
Current Control 0.02% resolution. 10 turn.
Overvolt control 1% resolution. 20 turn.

Transient response
1mS typical to settle within 50mV for 10-100% load change of 1μS rise time.

Protection

a) Both supply lines switched - (fuse in live).
b) Variable current limit.
c) Reverse voltage protection by parallel diode.
d) Forward voltage protection by diode. Maximum protection voltage 65V.
e) Regulator short circuit fuse - (fuse holder in the base of unit).
f) SCR Crowbar, user programmable. Max steady state current 10.0A.
g) DC output fuse - (fuse holder in the base of unit).
   Works in conjunction with the SCR.
h) Mains high/low detection - Disables output.

Float Voltage
The maximum dc float voltage of any terminal is 200V with respect to ground.

3.3 METERS AND INDICATORS

By custom LCD display driven by microprocessor. Simultaneous presentation of both volts and amps in 10mm high digits and analogue bar graph user selectable to indicate volts, amps or power. Back lighting is used to enhance contrast.

NOTE:- The display is still viewable in event of back light failure.

Voltmeter
fsd, 35.00 volts
Resolution 10mV
Accuracy ± (0.2% of reading + 0.1% fsd).

3. SPECIFICATION

3.1 MAINS INPUT

Voltages: 220V or 240V ±10%. 950VA maximum.
110 or 130V ±10%. 1000VA maximum. *(Made to special order)*

Frequency: 50/60Hz ±10%.

Range Change: Position of fuse drawer on IEC mains connector socket.

Connection: Via IEC lead 2.0 metres long (supplied).

3.2 OUTPUT

Single output 0-35V and up to 10.0 amps.

Output Switch
The output has an ON/OFF switch. With the switch in its OFF state, the meter displays the prospective volts and amps settings. The presence of the 'Preview' legend and the absense of either the 'CV' or 'CI' legends indicate that the output is OFF.

Output Terminals
4 mm binding posts providing the output terminals, sense terminals and safety earth. Shorting links are provided to connect sense and output.

Remote Sense
Compensates for up to 0.5V drop per load lead.

Line Regulation
CV - Less than 0.01% + 2mV for 10% line voltage change from nominal.
CI - Less than 0.01% + 200μA for 10% line voltage change from nominal.

Load Regulation
CV - Less than 0.01% + 2mV for zero to full load change.
CI - Less than 0.1% + 2mA for zero to 35V output.

Output Ripple and Noise
CV mode: (@ Full load maximum voltage.)

RMS Ripple		**Pk-Pk Ripple**	
Maximum	Typical	Maximum	Typical
500μV	300μV	2.5mV	1.0mV

NOTE : Ripple can be improved significantly with a small X-type capacitor to ground.

CI mode: (@ Full load maximum voltage.)

RMS Ripple		Pk-Pk Ripple	
Maximum	Typical	Maximum	Typical
1mA	800μA	3mA	2mA

Temperature Coefficient of Output Voltage
0.02% per °C

Controls
Volts control 0.02% resolution. 10 turn.
Current Control 0.02% resolution. 10 turn.
Overvolt control 1% resolution. 20 turn.

Transient response
1mS typical to settle within 50mV for 10-100% load change of 1μS rise time.

Protection

a) Both supply lines switched - (fuse in live).
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g) DC output fuse - (fuse holder in the base of unit).
Works in conjunction with the SCR.
h) Mains high/low detection - Disables output.

Float Voltage
The maximum dc float voltage of any terminal is 200V with respect to ground.

3.3 METERS AND INDICATORS

By custom LCD display driven by microprocessor. Simultaneous presentation of both volts and amps in 10mm high digits and analogue bar graph user selectable to indicate volts, amps or power. Back lighting is used to enhance contrast.

NOTE:- The display is still viewable in event of back light failure.

Voltmeter
fsd, 35.00 volts
Resolution 10mV
Accuracy ± (0.2% of reading + 0.1% fsd).

Ammeter
fsd, 10.00 amps
Resolution 10mA
Accuracy ± (0.3% of reading + 0.1% fsd).

Indicators
CV, CI, OVL, OVL-Set, Preview and OT.

Bargraph
27 segment user selectable to display volts, amps or power. (Intended for use as a trend indicator).

Bar graph full scale set to :
Power fsd = 350W
Amps fsd = 10A
Volts fsd = 35V

3.4 MECHANICAL

Physical Size
HEIGHT - 170mm
WIDTH - 215mm
DEPTH - 400mm
WEIGHT - 9.7kg

Accessories Provided
2.0 metre IEC CEE22 mains lead with free end.
Handbook.
Spare fuses.

3.5 SAFETY

Designed to meet BS4743 (IEC348).

Isolation
Each unit is checked for insulation in the following places:-

Input (Live and Neutral linked) to output (terminals joined together and to earth) at 1500V ac leakage to be less than 10mA. Outputs (linked together) and earth at 700V dc to be more than 10MΩ.

Note:- Discharge 700V with a resistor of ≥500KΩ.

Environmental
Designed to meet:

Operating ambient -	-5 C to +50 °C (Derate current linearly to 5A from 35 to 50 ° C)
Storage -	-40 C to +70 °C
Operating RH -	0% to 90% non condensing.

4. INSTALLATION

4.1 SUPPLY VOLTAGE

Confirm by reference to the back panel controls that the Farnell PSD3510A is set to match the local mains supply. The power supply is normally factory set for 240V ac operation.

To change the input voltage setting proceed as follows:-

a) DISCONNECT mains lead from supply.
b) Remove the fuse holder, which is integral with the IEC socket on the back plate (See *Fig 4.1*).
c) Replace the fuse holder having rotated it through 180°.
d) The fuse holder should now read the correct voltage, the right way up, either 220V or 240V. RECONNECT the IEC lead, the supply is ready for use.

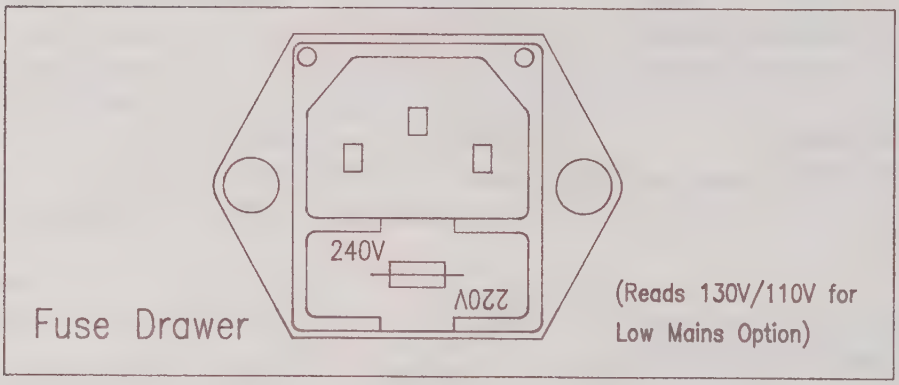


Fig 4.1 IEC Connector, Fuse & Tap Change Assembly

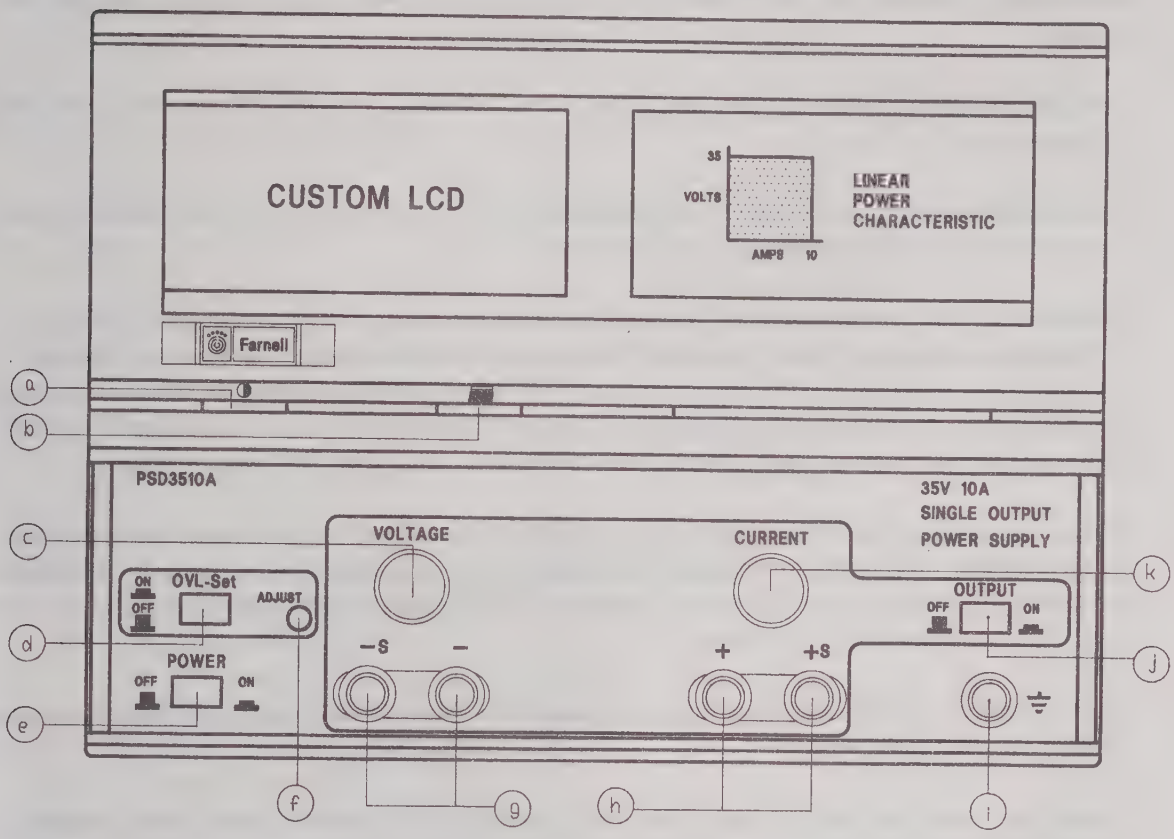
4.2 MAINS CONNECTION

The unit is provided with a mains lead terminated in a standard IEC connector at one end. The free end should be connected to a suitable plug. (Note any solder tinning of wires must be removed before connecting to the plug). The PSD3510A is classified as Safety Class 1 equipment and it is imperative that the earth lead (green/yellow) is connected to a known integrity earth, otherwise the chassis may float to a dangerous potential.

4.3 LOCATION

The Farnell PSD3510A is forced air cooled. Care should be taken not to obstruct any inlet or outlet vents.

5. OPERATING INSTRUCTIONS



KEY

(a) - Viewing angle selector button
(b) - Bargragh selector button
(c) - Ten-turn voltage control potentiometer
(d) - Over-voltage preview button
(e) - Input power switch
(f) - Twenty turn over-voltage adjust potentiometer
(g) - Negative output and negative sense terminals
(h) - Positive output and positive sense terminals
(i) - Earth terminal
(j) - Output switch
(k) - Ten-turn current control potentiometer

Fig 5.1 The front panel

5.1 FIRST TIME OPERATION

Before turning ON confirm that the unit is set to the correct mains input voltage and the correct rating of mains fuses are fitted. It is essential that the mains earth lead is connected to ground.

With the OUTPUT switch (*j*) and the mains INPUT switch (*e*) set to OFF connect to the local mains supply.

Turn current and voltage controls fully anticlockwise. Ensure links are in place between each sense terminal and it's adjacent output terminal.

Depress the mains input switch to ON and note that the meter display progresses through an initialisation sequence, before displaying voltage and current setting. These are the **preview** values displayed whenever the output switch is OFF and is indicated by the 'Preview' legend. If the meter is to be viewed at an angle other than 90°, pressing the view angle button (*a*) will step through four pre-set view angles. Select the setting that gives the best contrast.

Rotate the voltage control potentiometer (*c*) clockwise and note the increasing reading of the voltage display. This increase can also be viewed on the bargraph by depressing the Bargraph button (*b*) until VOLTS are displayed. With the VOLTS control fully clockwise a reading of at least 35.00 volts should be displayed.

By rotating the CURRENT control (*k*) clockwise note that the ammeter display increases until at least 10.00A is displayed.

Switch the output ON by depressing switch (*j*), note that the ammeter display has reduced to almost 00.00 and that the CV legend replaces the Preview legend.

***NOTE:** The OVL is factory set for 36.5 volts.*

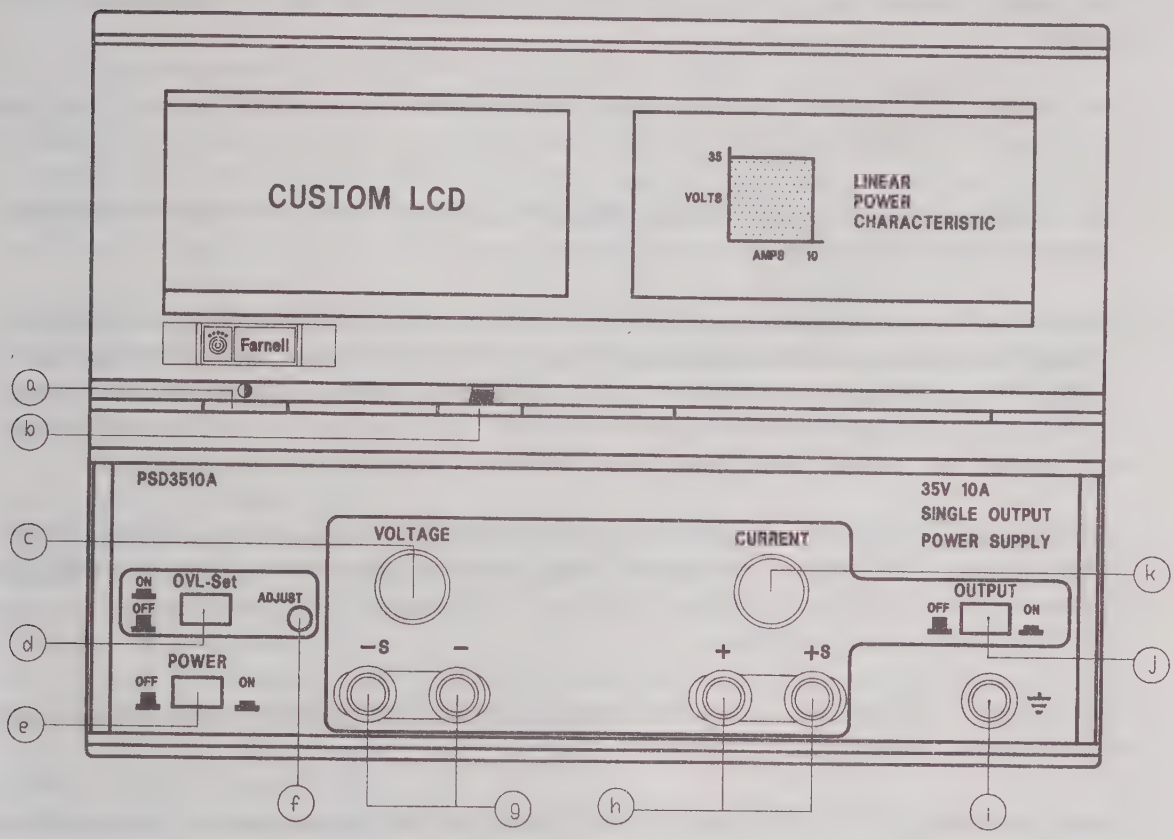
If the OVL flag appears, the AMPS display will show the current at the limit setting and the voltage will fall to around 1V, representing the volt drop across the SCR. The overvoltage potentiometer needs rotating clockwise to raise the trip level. This is accessed through a hole in the front panel (*f*). The trip level can be previewed by pressing the OVL-Set button (*d*).

Reduce the output voltage to approximately 5 volts and place a short circuit across the output terminals (*g & h*). Note that the voltmeter reading reduces and that the ammeter now reads the current flowing. Note too that the CV legend is extinguished and that the CI legend is presented.

Remove the short and set the voltage to approximately 35V. Use a trimming tool or a small screwdriver to rotate the OVL potentiometer anticlockwise which will reduce the trip level. This is accessed through a hole in the front panel. When it trips the OVL flag in the display will come on, the voltage will reduce to around 1V and the current will increase to the limit setting. To reset, reduce the output voltage and switch the output OFF then ON again.

The unit is now ready for use.

5. OPERATING INSTRUCTIONS



KEY

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(g) - Negative output and negative sense terminals
(h) - Positive output and positive sense terminals
(i) - Earth terminal
(j) - Output switch
(k) - Ten-turn current control potentiometer

Fig 5.1 The front panel

5.1 FIRST TIME OPERATION

Before turning ON confirm that the unit is set to the correct mains input voltage and the correct rating of mains fuses are fitted. It is essential that the mains earth lead is connected to ground.

With the OUTPUT switch (*j*) and the mains INPUT switch (*e*) set to OFF connect to the local mains supply.

Turn current and voltage controls fully anticlockwise. Ensure links are in place between each sense terminal and it's adjacent output terminal.

Depress the mains input switch to ON and note that the meter display progresses through an initialisation sequence, before displaying voltage and current setting. These are the **preview** values displayed whenever the output switch is OFF and is indicated by the 'Preview' legend. If the meter is to be viewed at an angle other than 90°, pressing the view angle button (*a*) will step through four pre-set view angles. Select the setting that gives the best contrast.

Rotate the voltage control potentiometer (*c*) clockwise and note the increasing reading of the voltage display. This increase can also be viewed on the bargraph by depressing the Bargraph button (*b*) until VOLTS are displayed. With the VOLTS control fully clockwise a reading of at least 35.00 volts should be displayed.

By rotating the CURRENT control (*k*) clockwise note that the ammeter display increases until at least 10.00A is displayed.

Switch the output ON by depressing switch (*j*), note that the ammeter display has reduced to almost 00.00 and that the CV legend replaces the Preview legend.

***NOTE:** The OVL is factory set for 36.5 volts.*

If the OVL flag appears, the AMPS display will show the current at the limit setting and the voltage will fall to around 1V, representing the volt drop across the SCR. The overvoltage potentiometer needs rotating clockwise to raise the trip level. This is accessed through a hole in the front panel (*f*). The trip level can be previewed by pressing the OVL-Set button (*d*).

Reduce the output voltage to approximately 5 volts and place a short circuit across the output terminals (*g & h*). Note that the voltmeter reading reduces and that the ammeter now reads the current flowing. Note too that the CV legend is extinguished and that the CI legend is presented.

Remove the short and set the voltage to approximately 35V. Use a trimming tool or a small screwdriver to rotate the OVL potentiometer anticlockwise which will reduce the trip level. This is accessed through a hole in the front panel. When it trips the OVL flag in the display will come on, the voltage will reduce to around 1V and the current will increase to the limit setting. To reset, reduce the output voltage and switch the output OFF then ON again.

The unit is now ready for use.

5.2 CONNECTING THE LOAD

The general rule is to use a wire gauge greater than the minimum necessary to carry the current, in order to maintain adequate regulation at the load.

Where regulation is critical then remote sensing can be used.

5.3 SETTING VOLTAGE AND CURRENT WITH THE LOAD CONNECTED

A feature of the Farnell PSD3510A is that both the voltage and current levels can be set without the need to disconnect the load. When the output switch is OFF the display previews the output settings this is indicated by the 'Preview' legend.

Upon depression of the output switch the load is electrically connected to the power supply and the meter gives simultaneous indication of the voltage and current flowing. The CV and CI legend indicates whether the output is driven in constant voltage or constant current modes respectively.

5.4 CV AND CI OPERATION

The PSD3510A provides automatic changeover from CV (Constant Voltage) to CI (Constant Current), with status indication provided on the LCD meter.

Constant Voltage Legend - CV

The CV mode of operation is the more usual, where the power supply delivers Constant Voltage until such times as the load current demand exceeds the current limit setting.

Constant Current Legend - CI

At this point, the power supply operates in CI and the output voltage falls to a level determined by: (load resistance)x(current limit). On removal of the overload (ie. load demand less than current limit setting) the power supply reverts to CV operation.

> ***NOTE:*** *Although the current control can be used to limit the dc current in the range from maximum down to 1% of maximum, it must be remembered that the instantaneous current is independent of any such setting. This is due to the output capacitance, which is needed to stabilise the output. The instantaneous current is thus a function of output voltage, capacitor value, lead and source impedance and the load impedance.*

5.5 OVER VOLTAGE PROTECTION

The Farnell PSD3510A features an SCR crowbar which protects the output against the following conditions:

* Turning the VOLTAGE setting pot too high.

* Placing an external voltage (eg. a battery) on the output which exceeds the trip level. This will blow the output fuse (F203) if the internal resistance of the external source is low enough. (12A F type)

* Internal series regulator failure, ie. regulator short circuit. This will blow the regulator fuse F202. (12A F type)

OVL Programming

The setting potentiometer is accessed with a trimming tool or a small screwdriver through a hole in the front panel between the voltage and current controls (*Fig 5.1 f*) rotating this clockwise increases the trip level. There are 20 turns from the minimum to the maximum value ie. about 1.9V/turn. However there are no end stops which means over winding the pot will make it seem to require more than this. The OVL level can be viewed at any time on the display by pressing the OVL-Set button (*Fig 5.1 d*). Maximum OVL trip level is nominally approx 38V.

Safety Points

The SCR that performs the crowbar has been designed to withstand up to 12A for short periods of time and up to 10A sustained current.

* When charging batteries any current over 12A will blow the output fuse. This would be provided by the shorting of the batteries through the SCR. In some cases this current might not be available to the battery owing to its internal resistance, but it may still be a fire hazard. Extra protection would then be required.

* Avoid leaving the PSD3510A in a tripped out state for long periods of time.

5.6 REMOTE SENSING

The facility can compensate for up to 0.5V drop in each load lead whilst maintaining specified regulation at the load. To use this facility disconnect the links between output and sense terminals.

Using a wire gauge that will handle the current whilst producing a volt drop of less than 0.5V, connect the output terminals to the load. Connect the sense terminals to the load ensuring "+ve sense" is taken to "+ve load" (the wire gauge is not important since there is negligible current flow).

To maintain general performance it is recommended that like polarity output and sense leads should be twisted together and that the leads should be decoupled by at least a 0.47μF capacitor connected directly across the load (See *Fig 5.2*)

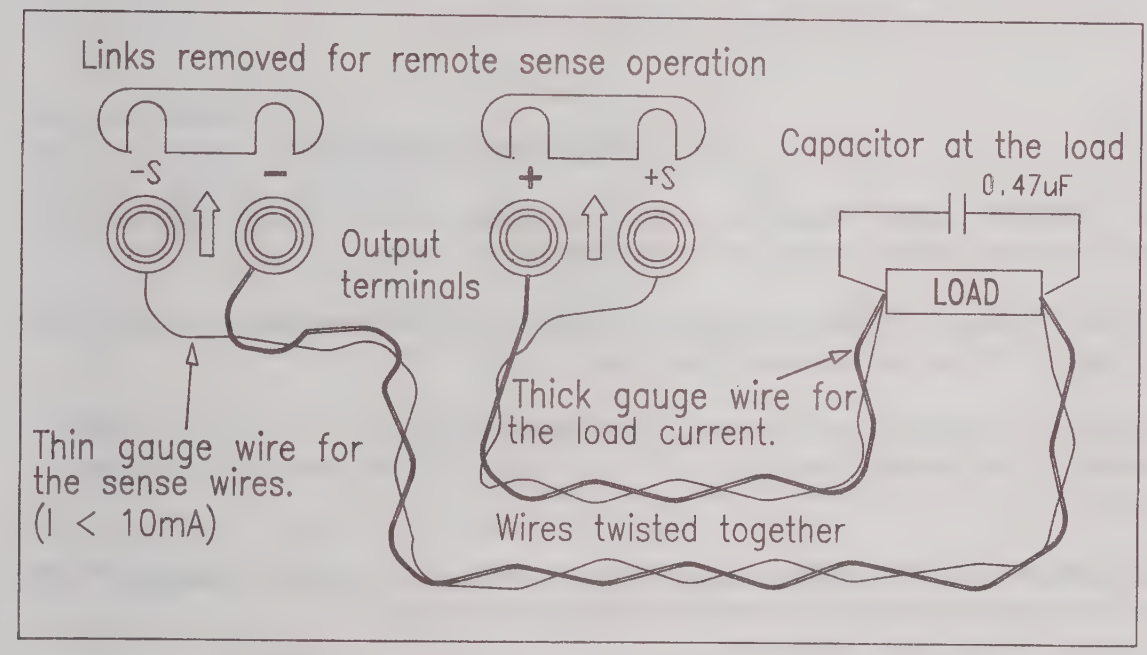


Fig 5.2 Remote Sense

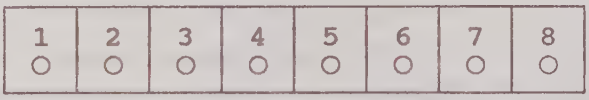
5.7 EARTHING THE LOAD

As supplied, the output is floating from chassis (safety earth) and can be floated up to a maximum dc potential of 200V dc (including output volts) away from chassis (earth terminal).

If desired either the +ve or -ve terminal can be connected to the earth terminal to provide an output negative or positive with respect to ground.

5.8 REMOTE PROGRAMMING

The remote programming terminal block shown below in *Figure 5.3* is mounted in the centre of the backpanel :



Term No	Description
1	**V SOURCE** - Voltage programming source
2	**V PROG** - Programme voltage
3	**V OUT** - Front panel voltage pot wiper
4	**I SOURCE** - Current programming source
5	**I PROG** - Programme current
6	**I OUT** - Front panel current pot wiper
7	**COMM(+S)** - Common
8	**VαI OUT** - Current sense

Figure 5.3 - Remote Programming Terminal Strip

The **V SOURCE** Terminal outputs an accurate 1mA current source to develop voltages of 0-5V across 0-5k resistors when used in the resistance programme mode.

V PROG programmes the voltage output of the supply. A 5V input produces an output of 35V (full scale). A 5% over programming is permitted.

V OUT is the output from the front panel VOLTAGE potentiometer. 0-5V on the **V OUT** terminal = 0-35V on the output. It has to be linked to the **V PROG** terminal for front panel operation.

The **I SOURCE** Terminal outputs an accurate 1mA current source to develop voltages of 0-5V across 0-5k resistors when used in the resistance programme mode.

I PROG programmes the current output of the supply. A 5V input produces an output of 10A (full scale). A 5% over programming is permitted.

I OUT like **V OUT** it is the output from the CURRENT potentiometer that needs to be connected to the **I IN PROG** terminal for local operation.

The **COMM**mon terminal is the same as the +Sense terminal on the front panel and can be used as the "negative" terminal for programming.

The **VαI OUT** gives a 0 to 5V output for 0 to full scale current (0-10A) to be used in parallel mode.

The following are examples of local and remote applications.

Local (Front Panel) Operation

The front panel control output has to be linked to the programming input as shown below:

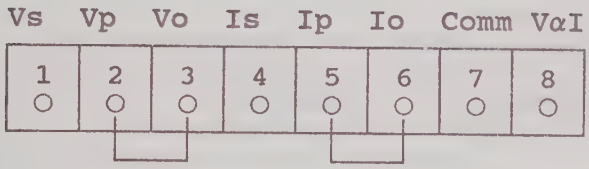


Fig 5.4 Rear Terminal Block - connected for local operation

Remote Operation

The links should be removed and replaced with voltage sources of 0-5V used to programme the required voltage and current.

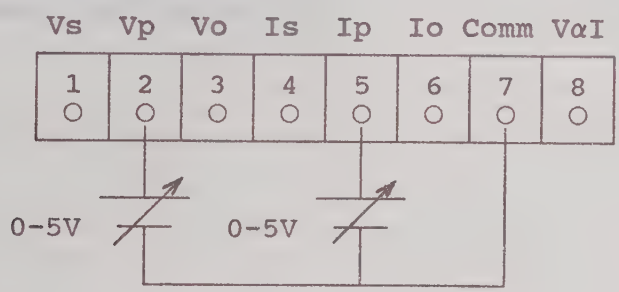


Fig 5.5 Rear Terminal Block - connected for remote operation

Resistance Operation

The links should be removed and replaced with 0 to 5kΩ resistors used to programme the voltage and current required.

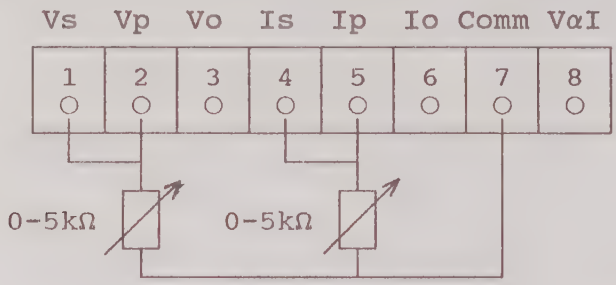


Fig 5.6 Rear Terminal Block - connected for resistance operation

5.9 PARALLEL OPERATION

The PSD3510A can be used in parallel with other PSD3510A units to give more current if required. The units can be connected in parallel remembering that:

* The 4mm terminal pillars are rated at 15A. Currents greater than this should be taken from a separate junction point.

* A current of 20A will require 4mm² (cross sectional area) cable for load lead lengths of around 1m to ensure regulation stays within the capabilities of remote sense.

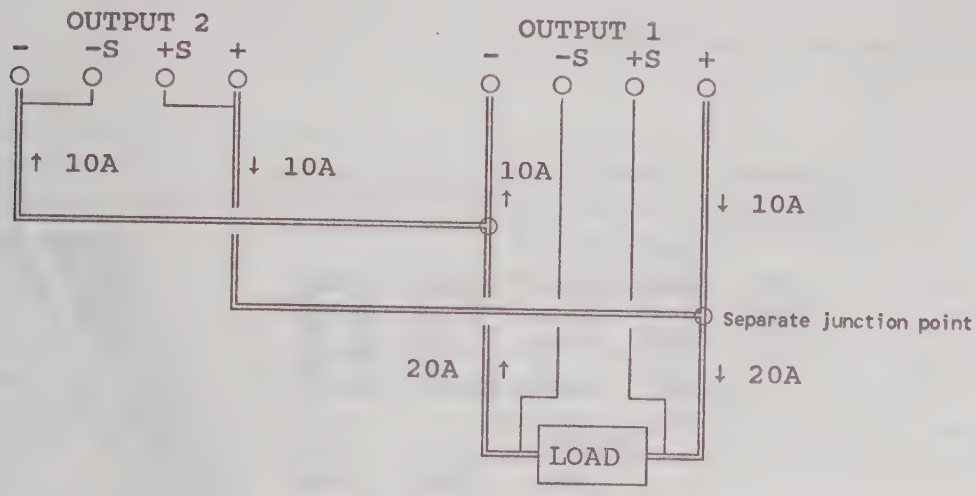


Fig 5.7 Output Connections - for parallel operation

Once the outputs have been correctly connected set the Output 2 voltage slightly larger than the maximum required by the circuit. Output 2 will be running in CI mode producing the same current as Output 1. This is achieved using the remote programming Terminal Block. Output 1's current sense (VαI OUT) output is used to programme Output 2's current input (I PROG).

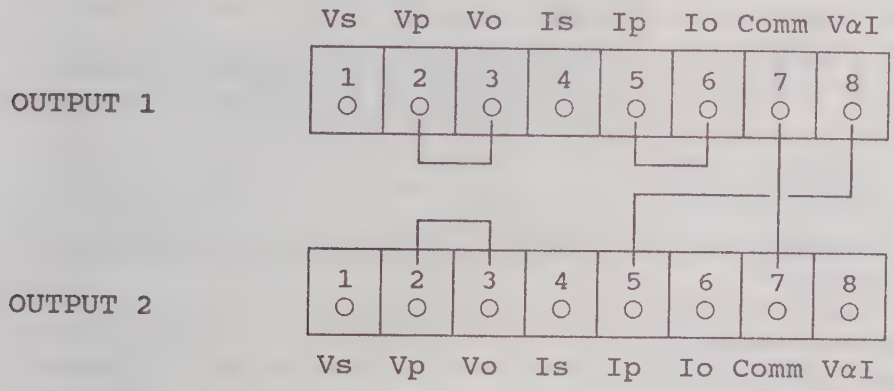


Fig 5.8 Rear Barrier Strip - connected for parallel operation

It is possible to use Output 2 to control Output 1 simply by reversing the way the units are connected up on the rear terminal block.

5.10 INTELLIGENT PANEL METER

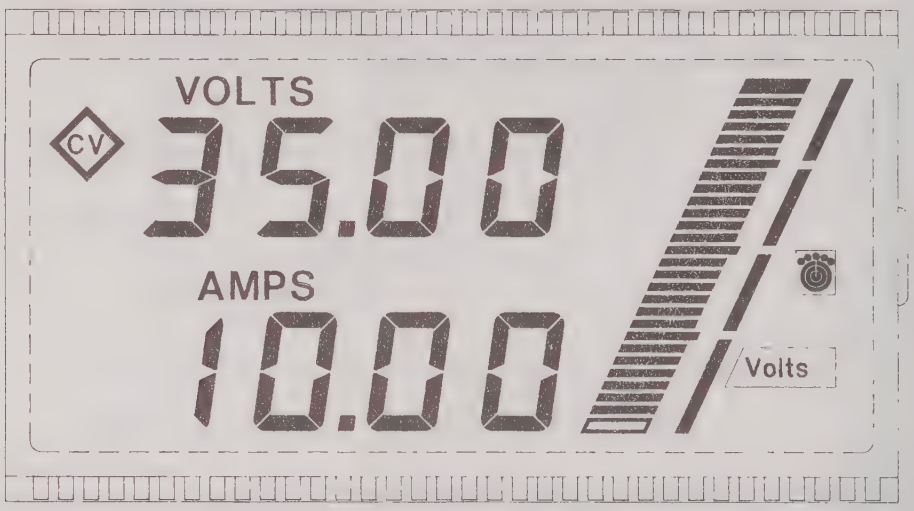


Fig 5.9 The Intelligent Panel Meter

A unique feature of the P Series Power supply is a micro-processor controlled panel meter designed to meet the needs of a modern bench power supply. All the important information can be conveyed:

* Voltage, up to 4 significant figures.
* Current, up to 4 significant figures.
* Power, on a 27 segment bar graph. (The bar graph can also show voltage and current)
* CV/CI mode indication.
* OVL-Set (Over voltage set) viewable user programmable limit
* OVL (Over voltage limit) trip indication.
* OT (Over temperature) trip indication
* Preview mode (Preset Voltage and Current) indication

View Angle Control

Four distinct levels can be stepped through. The turn on default condition is for straight on viewing.

Bargraph mode select

Power, current or voltage can be displayed as an analogue level in this way. The turn on default condition is the 'power' mode.

Full scale on the Bargraph is used to indicate maximum power of 350 watts, a maximum voltage of 35 volts or a maximum current of 10 amps.

6. CIRCUIT DESCRIPTION

6.1 MAINS INPUT

The PSD3510A power supply is made up of a mains step down transformer, DC rectifying components, a series of regulator transistors and the associated control circuitry, including a single digital LCD meter displaying volts and amps simultaneously, resulting in a single smoothed DC output of 35 volts at up to 10 amps.
Raw mains is supplied to the primary input of a mains toroid via a front panel operated mains switch (SW201). Both live and neutral inputs are switched and the live input is fuse protected after SW201 by F201, which is interchangeable between the 220V and 240V ac inputs.
The toroid has four secondary taps. One supplies 8V ac (not used), two are 18V ac (low current, centre tapped for the control board positive and negative supply rails and higher current for the LCD supply, LCD backlighting and DC fan) and a 57V ac 10A tap for the main power supply output.

The main secondary tap is full wave rectified by BR201 and smoothed to a raw dc state by a 33,000uF capacitor C202. The positive is fed to the collector of the series regulator transistors whilst the negative is fed directly to the negative output terminal through a protection fuse F203. The series regulator's output is taken to the positive output terminal through a protection fuse F202 and a four terminal current sensing resistor R6.

6.2 THE SWITCHING REGULATOR

The supply for the 15 volt dc fan, LCD display and backlighting is created using an L4960 monolithic power switching regulator running at approximately 100kHz. This device is used to reduce the internal heat dissipation and improve the efficiency of the supply. BR1 rectifies the ac voltage from the toroid and C8 and C9 provide a raw dc voltage onto the input of the switching regulator U3. C13 and R11 set the switching frequency whilst R10, C10 and C11 determine the regulation loop gain characteristics. R12 and R13 set the output voltage. This 15 volt output is fed to the fan through a 27 ohm resistor R14 which acts as a current limiter and allows the fan to run at half speed. Two thermal switches TH201 and TH202 are connected in parallel across R14. One is mounted on the series regulator heatsink and the other is potted inside the mains toroid. If either of the thermal switches reaches temperature they will close and short out R14. This will cause the fan to run fast and blow more air over the heatsink and toroid cooling them down. Eventually the switch will open again and the fan will run at half speed once more. Also connected to the output of U3 is a 12 volt regulator U4 which supplies the rails for the LCD control circuit. U4 also controls a power transistor Q2 which supplies the current taken from U3 output for the LCD bulb backlighting. Q2 drops approximately 0.5V below 12 volts so that the bulbs are slightly under run to ensure their long life.

6.3 POSITIVE AND NEGATIVE CONTROL SUPPLIES

U1 is a positive 12 volt regulator and U2 a negative 12 volt regulator. Taking their raw dc from the fullwave rectified ac of the centre tapped low current 30V secondary tap, these two regulators supply the control board with the necessary +12V and -12V control rails.

6.4 CONTROL AMPLIFIERS

U8-B forms the current control loop side of the control circuit. It's inverting input is fed from a differential op amp U8-A measuring across the current sense resistor R6 which develops 250mV for 10 amps flowing through it. U8-A is a precision low offset operational amplifier with a gain of 20 giving 5 volts out for 10 amps flowing. The non-inverting input of U8-B is connected to the remote programme terminals on the back panel to be controlled either by resistance or by the front panel current control potentiometer P2. U8-C forms the voltage control loop side of the control circuit. It's inverting input is fed from a differential op amp measuring across the sense terminals. This op amp is set up to have a gain of minus 7 therefore giving 5 volts out equivalent to 35 volts across the sense terminals. The non-inverting input of U8-C is connected to the remote programming terminals on the back panel to be controlled either by resistance or by the front panel voltage control potentiometer P1. The op amp will endeavour to keep both inputs the same by altering it's output voltage. So if the programmed voltage is higher than the voltage across the sense, the op amp output will be high. This in turn drives the 'boost' transistor Q8 on which drives the series regulator transistor driver Q9. This then delivers all the base current required to drive 10 amps through the 12 series regulator transistors. The voltage loop remains in control until the current loop op amp output goes low i.e. When the programmed current is matched by the actual current flowing. When this happens the unit automatically changes over from constant voltage mode to constant current mode. U8-B controls the drive to the series regulators until the programme current is once again taken above the actual current and the unit returns to constant voltage mode.

6.5 PROTECTION AND OUTPUT ENABLE

Several forms of protection are provided in the circuit. A reverse polarity diode is connected directly across the output terminals. A forward voltage protection diode is connected across the collector and emitter of the series regulators to protect against large voltages being connected across the output. A fuse immediately after the emitters of the series regulators protects against transistors becoming short circuit. Pre-setting of overvoltage is provided. A voltage derived across P3 representing zero to approximately 40 volts at the output is fed to the non-inverting input of comparator U7-C. The inverting input is connected to the output of op amp U8-D which sees an exact proportion of the output voltage. If the inverting input goes above the non-inverting input then the output of U7-C will go low which pulls down the input to U7-B. If the unit is enabled, the output of U7-B will go low and turn on Q1, providing gate current to SCR1. Thus shorting out the output terminals. Between the cathode of SCR1 and the negative output terminal there is a protection fuse which will blow if the current through the SCR exceeds 12 amps. U9 is a precision quad comparator IC. U9-A and U9-B monitor the level of raw dc supplying the +12v rail. Their purpose is to keep the output off until the mains input is at it's proper level and the control rails are able to control the output correctly. Whilst the mains is at it's correct level the output of U9-A and B and U9-C will be high Q10 will be turned on and the relay RL1 will switch over. Normally, RL1 is connected across the base and emitter of the series regulators and disconnects the drive transistor from the drive signal. When the relay is activated, the drive is reconnected. When U9-A and B are high the non-inverting input to U9-D will be at 5v. For the output to be on, Q11 must also be on. Two signals can turn off Q11, sending the output of U9-D low and pulling down the voltage programming input to U8-C, therefore effectively turning off the output. These are from U7-A which monitors an overtemperature signal, and U6 which is indirectly coupled to the enable

switch. U7-A is a comparator that's output goes low, disabling the unit, if either one of two thermal switches TH203 or TH204 open indicating a state of over temperature. The normally closed thermal trips are potted inside the toroid and on the series regulator heatsink and are of a higher temperature trip level than those previously mentioned.

6.6 OUTPUT COMPONENTS

Output capacitance
- Approx 250μF required to stabilise the output.
- NOTE - A 1kΩ resistor provides a bleed for the output capacitance.
- 0.47μF for high frequency noise rejection. Aids stability.

Diode
- BYV32-100 double diode protects against reverse polarity connection of external sources, eg batteries.

SCR
- TIC126B provides an overvoltage crowbar.

6.7 RESISTIVE PROGRAMMING

U10-A is configured as an accurate 1mA current source. The op amp will attempt to drive enough current through transistors Q4 and Q5 so that the voltage across P6 and R50 is the same as that of the precision temperature compensated reference zener Z3. U10-A provides the current source for the voltage programming and an identical circuit using U10-B provides the current source for the current programming. By linking the current source and programme terminals together and connecting a zero to 5kΩ resistor between these and the common terminal the voltage or current or both can be defined.
A stable zero to 5 volt reference source can also be used to programme the output voltage and current. This is simply connected between the programme terminal and common.

6.8 METERING

The PSD3510A metering consists of a single multiplexed LCD displaying simultaneous volts and amps, constant voltage or constant current modes, over voltage set and over voltage, over temperature as well as an analogue bargraph with volts, amps or power indication.
In the disabled state, indicated by the 'Preview' legend, the meter displays the prospective output voltage entered onto the programme input as well as the required current limit level entered onto it's programme input. In the enabled state the meter reads the voltage from the output of U8-D, the differential op amp measuring across the output sense terminals, referenced to positive sense. The actual current flowing is measured by U8-A and fed to the amps meter referenced to positive sense.

Over voltage can be set on the front panel. When the non-latching OVL button is pressed the volts display is replaced by a figure that represents the set over voltage trip level. This can be changed using a trimming tool through the hole provided in the front panel or by the bus. If the output of the power supply was to reach this level the output will trip and the OVL legend will flash until the output is reset with the voltage below the trip level.

6.9 THE LCD METER

General

The LCD (Liquid Crystal Display) meter module utilises a unique custom designed display, which is back-lit to give good visibility and pleasant appearance. The display is driven by a micro-controller which also serves as the analogue to digital converter reading the inputs to the meter.

S4 Pin Out

Pin	Description	
1	Volts LO	ANALOGUE INPUTS
2	Volts HI	400mV (±5%) for full scale
3	Amps HI	Inputs can float ±1V from COMM
4	Amps LO	
5	COMM - Analogue and Logic common (+S).	
6	0V - Return current for bulbs and the rest.	
7	ON/OFF	Flag. OFF - Pulled low
8	CV/CI	Flag. CV - Pull up resistor
9	OVL-set	Flag. View - Pulled low
10	OVL	Flag. OVL tripped - Pulled low
11	BUS/LOCAL	Flag. LOCAL - Pull up resistor
12	TLQ1	BUS Talk/Listen/Request line 1
13	TLQ2	BUS Talk/Listen/Request line 2
14	OT	Flag. OT tripped - Pulled low
15	+12V bulbs - 6W @12V = 0.5A, run at 11.3V.	
16	+12V meter - 50mA max.	

Table 6.1
16 Way IDC Connector (S2)

Control board - Circuit Diagram: 2SZX0695

Power Supplies

Two 12V supplies are used, via socket S2, one is used solely for the two lamps which give the back lighting, and is in fact set to 11.3V to extend the life of the filaments and give greater resilience to mechanical shock. The other supply is decoupled and split to generate +5v and -7v rails using a -5v regulator (U8). The +5V supply is used by the digital ICs U1, U6 and U7, the other analogue ICs require the split supply.

Microcontroller

The microcontroller (U1) used is an 8031 which combines a microprocessor with data memory, input and output ports, and a 16 bit timer/counter. The programme memory is stored in the PROM (read only memory) U7. The address lines for the PROM are multiplexed by the microcontroller to save pins. This requires the use of a simple latch U6, to demultiplex them.

Power on reset is provided by C17 and R20 to pin 9, and the system clock is generated by the crystal VX1 (12MHz). The crystal driver circuit is provided within U1.

All other pins of the microcontroller used are for input or output to the rest of the circuit.

Analogue Input Circuit

The meter reads two analogue input channels, the volts and the amps. Both these inputs are scaled to the same full range absolute value of 400mV.

The LO input for amps is tied to the analogue ground of the meter circuit, however, the inputs for voltage are left floating. This is because the voltage measurement has to allow for common mode voltage differences caused by the drop generated in output leads when using remote sense. The voltage input is also inverted with respect to the current.

These inputs are connected to U5 which is an analogue multiplexer controlled by the microcontroller. This applies a BCD code to pins 9 and 10 of U5 which results in any of the four pairs of inputs, (1,12; 5,14; 11,4; 2,15), being connected to the output of U5 (pins 3 and 13). The output can then be volts input, amps input, reference input (-200mV from Z1), or ground.

Analogue To Digital Conversion

The signal conversion is performed by a dual slope convertor with auto-zero to eliminate circuit offset errors, and with common mode signal rejection.

The signal output from the multiplexer is buffered by the FET input op-amp U3 to give a consistent low impedance to the integrator circuit formed by the op-amp U4-A, R21 and C5. Capacitor C4 is the auto-zero capacitor linked to the virtual earth of the integrator and to the switched ground output of the multiplexer and so gives common-mode rejection.

The output from the integrator is compared with the system ground by the op-amp U4-B which is acting as a comparator, the output of which is directly read by the microcontroller.

During a conversion cycle the auto-zero is performed first. The input to the buffer/integrator is grounded and the output of the comparator/op-amp is shorted to the auto-zero capacitor by the analogue switch U2-A, the capacitor is then charged to compensate for the offset errors of the three op-amps.

The next phase is integrate, and the desired parameter, volts or amps, is switched in. The auto-zero short by U2-A is removed. The integration period is a fixed time length determined by the microcontroller.

The input is then switched to the negative fixed reference, the integrator then de-integrates and the output of the comparator U4-A as monitored by the microcontroller. This time the interval until the integrator output has returned to the starting level directly relates to the input signal level.

The microcontroller then processes this information and uses it to update the LCD display.

Status Inputs

Socket 2 pins 7, 8, 11 & 12 are 0 - 5V logic inputs. Pins 9, 10, 13 & 14 are multiplexed by the two remaining analogue gates in U2 to provide further logic inputs on the IC U1-A. The multiplexing is also controlled by U1. The function of each of these inputs is shown in Table 6.1. Zener diodes Z2 - Z5 provide protection for the analogue gates from external spurious voltage transients.

LCD Drive

S3 connects the LCD control board to the LCD display board which carries the LCD and its driver circuit. All the data to the driver is transmitted in a serial format.

LCD Display Board - Circuit Diagram: 3SZX0612

General

The LCD display board carries the custom LCD panel and the driver IC (U1). The selector switches for the bar graph and the preset viewing angles (with associated circuitry) are also mounted on this board. The circuit board material also performs the function of diffuser to the back-light. SW1 drives the interrupt line for the micro controller. In practice this steps through the bargraph functions defined in the software.

LCD Driver

U1 directly drives the LCD panel in the 1:4 multiplex mode required, this is set by software at power ON. R3-5, C1-3 & P1 and the multiplexer U3 with R10-12 determine the drive voltage levels for the back planes of the LCD, hence P1 controls the global view angle. The multiplexer can switch through 4 levels of view angle when driven from the counter circuit U2, R8,9, C7,8 and SW2. C8 and R9 provide the initial start up positive signal to reset the dual D-type flip flop (U2) so that the multiplexer IC (U3) resets to zero providing a short through Y0. This represents zero ohms on the "preset view angle" potentiometer (P1) so the view angle is automatically set to 90° or "straight on". The waveform diagram (*figure 6.2*) shows how the resistor values are selected when the view angle button is pressed. Hence pressing the switch steps through the angles.

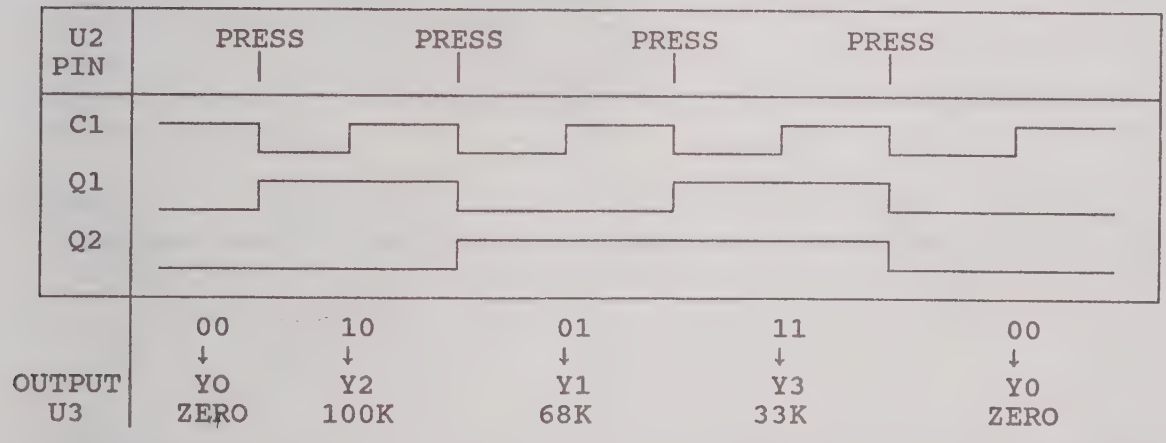


Figure 6.2
Waveform diagram

R2 and C4 reset the driver IC (U1) at power on and R1 sets the multiplex rate.

6.10 POTENTIAL MAP

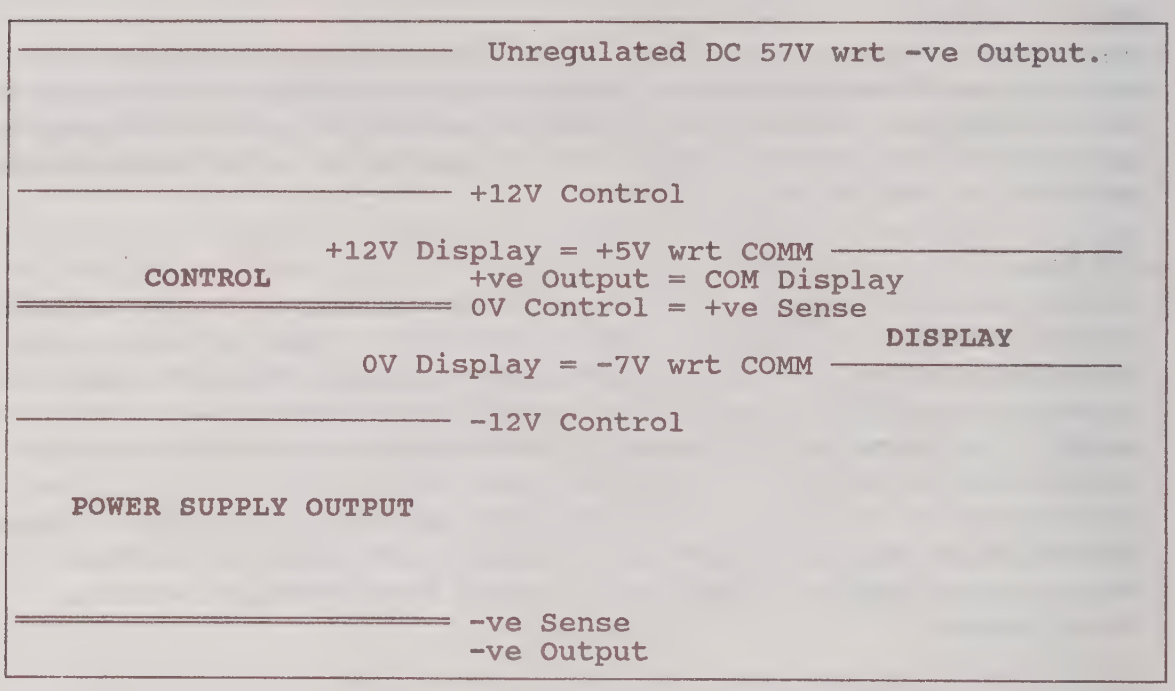


Figure 6.3
Potential Map

7. MAINTENANCE AND RECALIBRATION

7.1 MAINTENANCE

The Farnell PSD3510A is designed as a minimum maintenance product.

Recommended maintenance is limited to the removal of dust from within the unit and heat-sink area by blowing and brushing. Periodically the outside of the unit can be wiped with a cloth dampened with a mild detergent.

If preventative maintenance is required then we recommend after 5,000 hours operation that all fuses are replaced along with the LCD back light lamps. It should be noted that the LCD meters are still viewable even if both lamps fail.

Gaining Access to the PSD3510A

WARNING! Isolate unit from mains supply and disconnect any load from the output terminals. Turn the unit upside down. Unscrew the screws down each side of the cover. Flex the cover outwards and lift off.

Replacing Bulbs

Carefully detach the rear meter board from the 4 spacers and remove the bulb from its holder. The replacement must be an identical type and is available from Farnell Instruments Limited (see parts list for the order number).

7.2 RECALIBRATION

WARNING! This operation must only be carried out by qualified personnel who are conversant with working on 'live equipment'. The engineer must ensure that he takes all required precautions to protect himself and others from any hazard.

If required the PSD3510A can be returned to Farnell Instruments Limited or their agents for repair and recalibration.

Display

1. Two potentiometers for the display can be adjusted on the Control board using an insulated tool, from above once the cover has been removed.

   VOLTS - P4
   AMPS - P5

2. First ensure that the output switches are 'OFF'. Then turn the voltage control potentiometer fully anticlockwise. Turn the output 'ON' and measure the output voltage with a reference DVM. Check that the output is less than 50mV.

3. Turn the output potentiometer to approximately 35V and use the DVM to trim the voltage display with P4 to within ± 20mV. Ensure for these tests that the CV annunciator on the display is on.

4. Connect the output to a load capable of handling 10A with a reference ammeter of known

accuracy preferably 0.2% or better in series with the -ve terminal. Turn the current control potentiometer fully clockwise and set the load to approximately 10A. Set the ammeter displays to read an identical current ± 2 digits using P5. Turn the current control potentiometer anticlockwise and ensure the unit goes into constant current mode indicated by the 'CI' legend replacing the 'CV'. Turn the output and unit off.

Programming

5. Remove rear barrier strip link 2 & 3 and replace with a link between 1 & 2 and an accurate resistance of 5kΩ ±0.2% between this link and 7. Turn the unit on and adjust P6 to achieve 35 volts on the output ±0.1%. Turn output and unit off and move link to it's original position.

6. Remove rear barrier strip link 5 & 6 and replace with a link between 4 & 5 and an accurate resistance of 5kΩ ±0.2% between this link and 7. Turn the unit on and adjust P7 to achieve 10 amps on the display ±0.1%. Turn output and unit off and move link to it's original position.

7.3 GUARANTEE

The equipment supplied by Farnell Instruments Limited is guaranteed against defective material and faulty manufacture for a period of twelve months from the date of dispatch. In the case of material or components employed in the equipment but not manufactured by us, we allow the customer the period of any guarantee extended to us.

The equipment has been carefully inspected and submitted to comprehensive tests at the factory prior to dispatch. If, within the guarantee period, any defect is discovered in the equipment in respect of material or workmanship and reasonably within our control, we undertake to make good the defect at our own expense subject to our standard conditions of sale. In exceptional circumstances and at the discretion of the Service Manager, a charge for labour and carriage costs incurred may be made.

Our responsibility is in all cases limited to the cost of making good the defect in the equipment itself. The guarantee does not extend to third parties, nor does it apply to defects caused by abnormal conditions of working, accident, misuse, neglect or wear and tear.

7.4 SERVICE

In the event of difficulty, or apparent circuit malfunction, it is advisable to telephone (or telex) the Service Department or your local Sales Engineer or Agent (if overseas) for advice before attempting repairs.

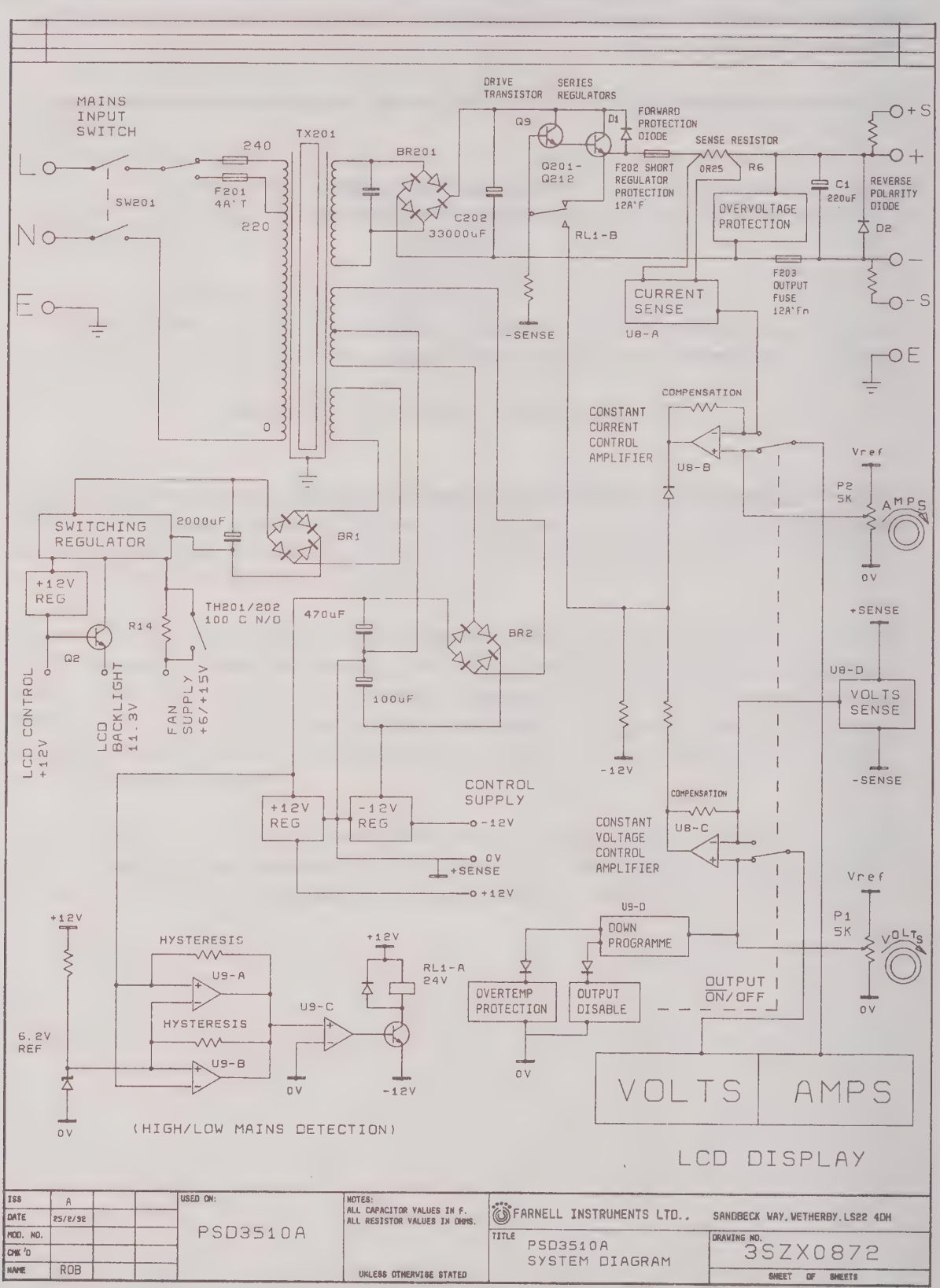
For repairs and maintenance it is recommended that the complete instrument be returned to:

The Service Department,
Farnell Instruments Limited,
Osborn House,
Sandbeck Way,
Wetherby,
West Yorkshire.
LS22 4DN

Tel: (0937) 581961 · Telex: 557924 Fax: 586907

Please ensure adequate care is taken with packing and arrange insurance cover against transit damage or loss.

8. CIRCUIT DIAGRAMS



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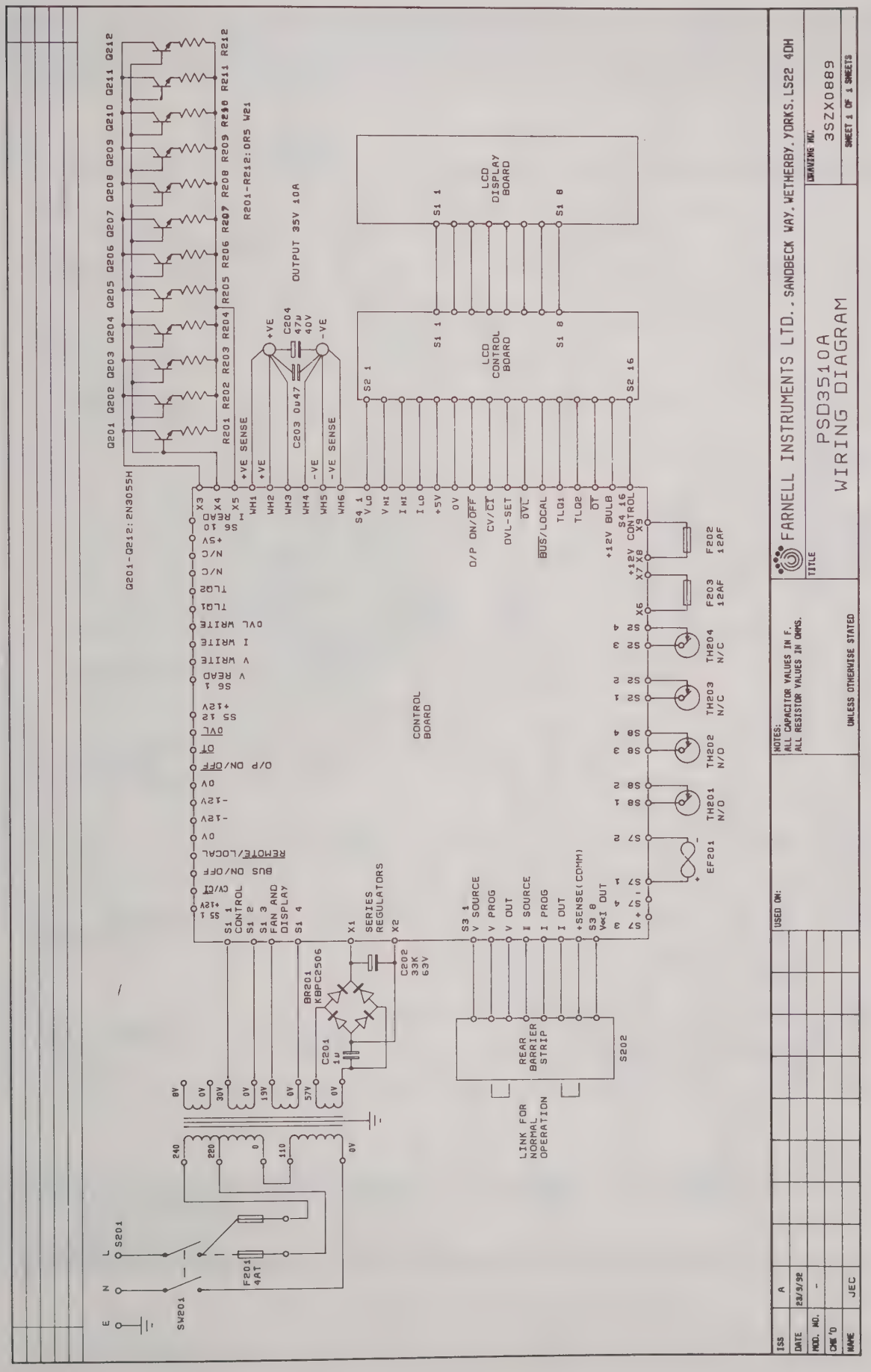
DATE	25/2/92				
MOD. NO.					
CHK'D					
NAME	ROB				

FARNELL INSTRUMENTS LTD., SANDBECK WAY, WETHERBY, LS22 4DH

TITLE: PSD3510A SYSTEM DIAGRAM

DRAWING NO. 3SZX0872

SHEET OF SHEETS


FARNELL INSTRUMENTS LTD., SANDBECK WAY, WETHERBY, YORKS, LS22 4DH
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WIRING DIAGRAM
DRAWING NO.
3SZX0889
SHEET 1 OF 1 SHEETS
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ALL CAPACITOR VALUES IN F.
ALL RESISTOR VALUES IN OHMS.
UNLESS OTHERWISE STATED
USED ON:
ISS A
DATE 23/3/92
MOD. NO. -
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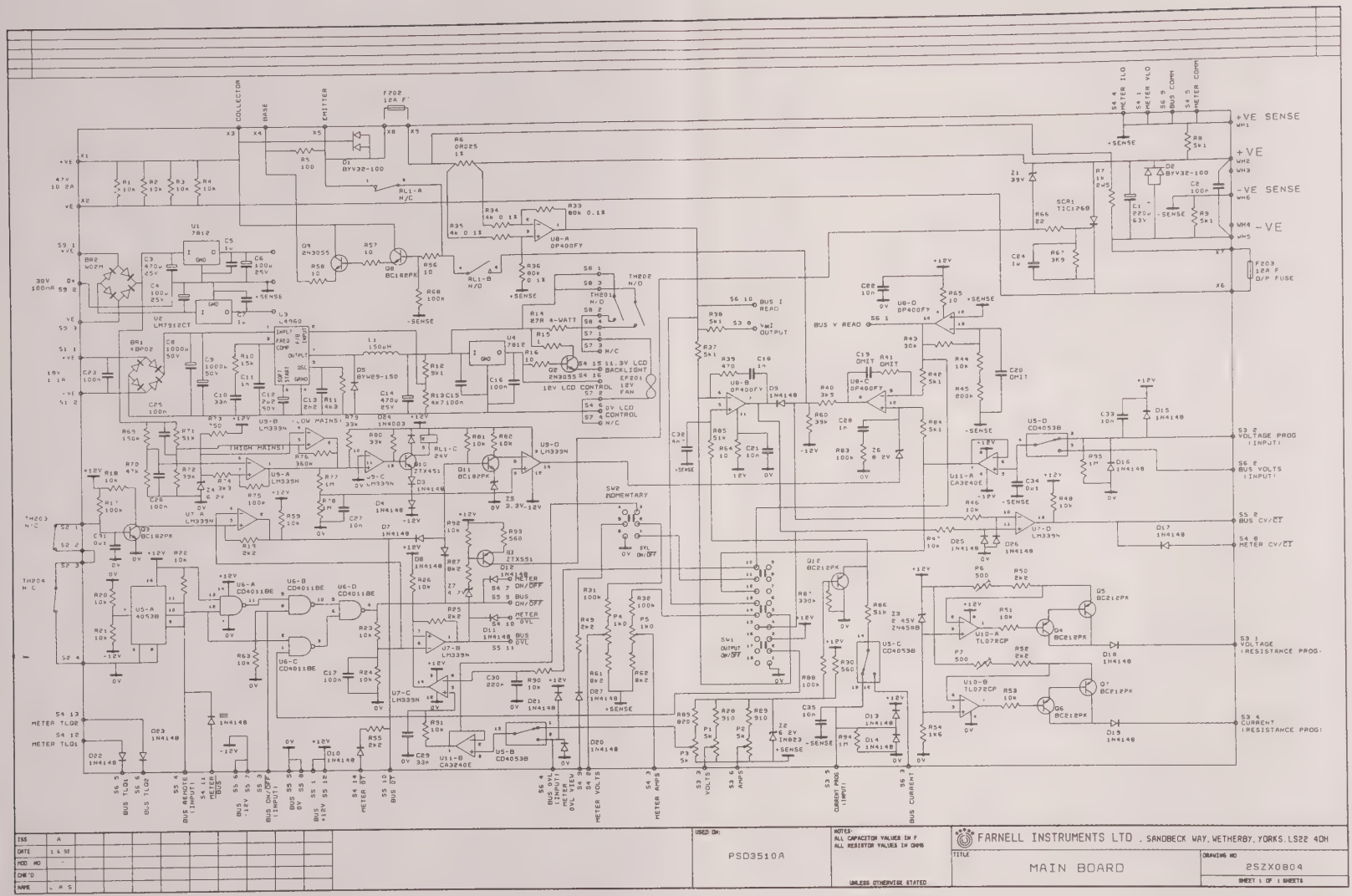
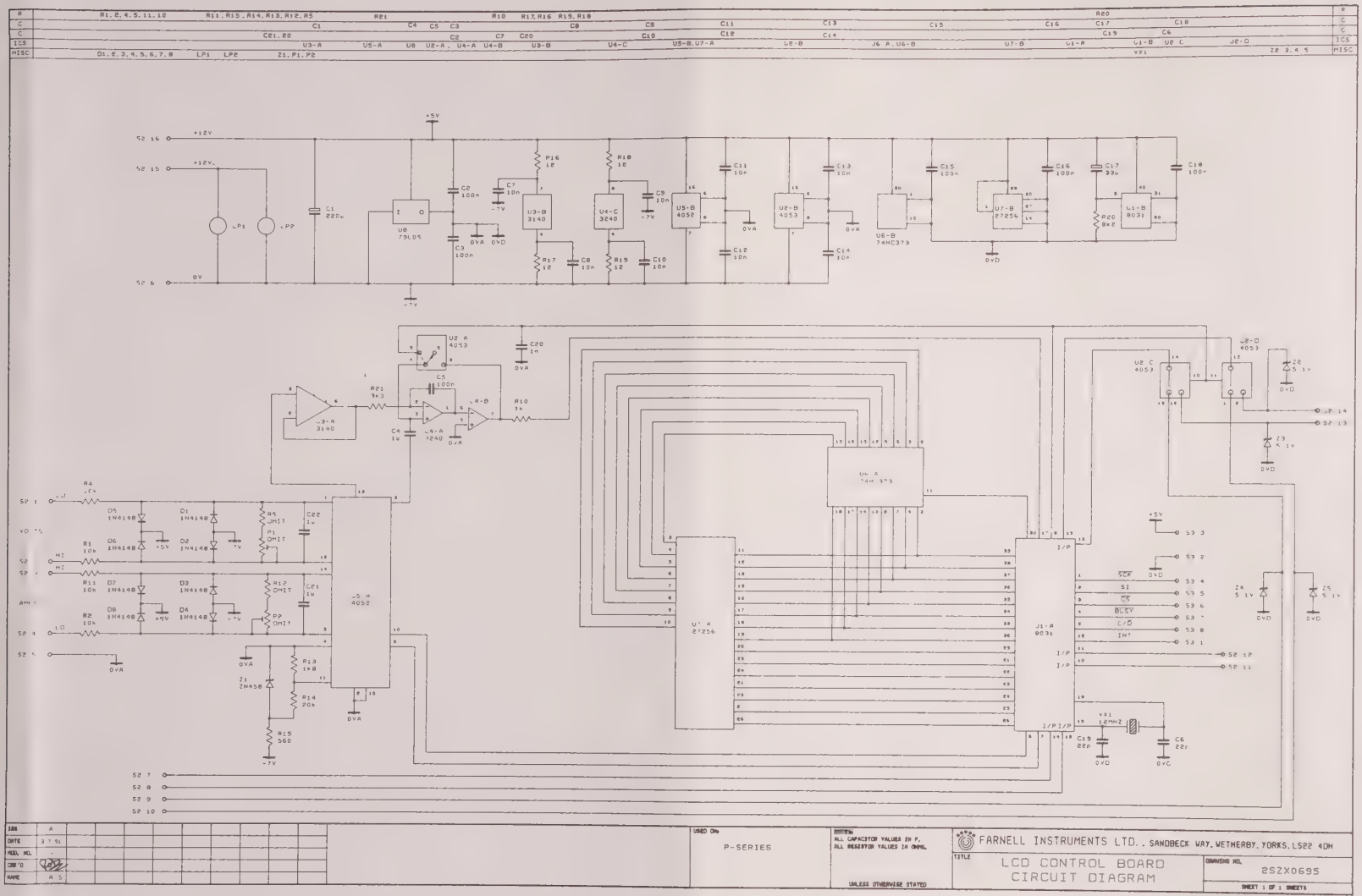
Q201-Q212: 2N3055H
R201-R212: 0R5 W2W
OUTPUT 35V 10A
+VE SENSE
-VE SENSE
C204 47µ 40V
C203 0u47
C202 33K 63V
C201 1µ
BR201 KBPC2506
CONTROL BOARD
SERIES REGULATORS
FAN AND DISPLAY
CONTROL
LCD CONTROL BOARD
LCD DISPLAY BOARD
REAR BARRIER STRIP
LINK FOR NORMAL OPERATION
S202
SW201
S201
F201 4AT
TH201 N/O
TH202 N/O
TH203 N/C
TH204 N/C
F202 12AF
F203 12AF
EF201
REMOTE/LOCAL
BUS ON/OFF
O/P ON/OFF
OVL WRITE
I WRITE
V WRITE
V READ
TLO1
TLO2
+5V
0V
-12V
+12V
N/C
BUS/LOCAL
OVL-SET
CV/CI
D/P ON/OFF
+12V BULB
OT
OVL
SENSE(COMM)
V OUT
I OUT
V SOURCE
I SOURCE
V PROG
I PROG


COLLECTOR
BASE
EMITTER
F202 12A F
+VE SENSE
+VE
-VE SENSE
-VE
F203 10A F O/P FUSE
BUS V READ
BUS I READ
VOLTAGE PROG (INPUT)
BUS VOLTS (INPUT)
BUS CV/CT
METER CV/CT
VOLTAGE (RESISTANCE PROG)
CURRENT (RESISTANCE PROG)
METER TLO2
METER TLO1
BUS TLO1
BUS TLO2
BUS REMOTE INHIBIT
METER BUS
BUS ON/OFF (INPUT)
BUS OVL
BUS +12V
METER OVL
METER VOLTS
METER AMPS
VOLTS
AMPS
CURRENT PROG (INPUT)
BUS CURRENT
SWP MOMENTARY
THERMAL MAINS
LOW MAINS
18V LCD CONTROL
BACKLIGHT
FAN
0V LCD CONTROL
VOLTS
AMPS
CURRENT

| | | |



ISS	A	USED ON: P-SERIES	UNLESS OTHERWISE STATED: ALL CAPACITOR VALUES IN µF, ALL RESISTOR VALUES IN OHMS.	FARNELL INSTRUMENTS LTD., SANDBECK WAY, WETHERBY, YORKS, LS22 4DH		
DATE	3 7 91			TITLE: LCD CONTROL BOARD CIRCUIT DIAGRAM	DRAWING NO. 2SZX0695	
MCD, MCL					SHEET 1 OF 1 SHEETS	
CHK'D						
NAME	A S					

COMPONENT SCHEDULE

Date: 23/09/92

Unit Item No: PSD3510A Description: BENCH P/S 0-35V/10A

Important explanation - Please read before ordering parts.
Due to limitations in the number of character spaces available the information in the circuit reference field has been abbreviated and the following notes are provided as a guide to its interpretation.

1. Where a component is used more than once on an assembly the alphabetic portion of the circuit reference for its second and subsequent locations has been omitted; eg. the circuit reference information for a component located at R1 and R6 will appear as: R1 6

2. The circuit reference numbers are presented in ascending decade blocks delimited by colons; second and subsequent numbers within a decade block represent only the unit value of the location (the tens and hundreds values being implied); eg. for a component located at R54, R57, R59, R82, R82, R87, R102, R110 and R112 the circuit reference entry will be: R54 7 9:82 7 9:82 7:102:10 2.

3. Where components are used in a series of neighbouring circuit reference locations the circuit reference numbers are represented as inclusive blocks using a hyphen; eg. for a component located at R16, R19, R21, R24, R25, R26, R31, R37, R38, R39, R40, R44, and R46 will be represented as R16 9:21 4-6: 31 37-40 4 6 (An exception to the rules occurs when a series crosses a decade block in which case the tens value is inserted.

4. Comments are preceded by a semicolon.

When ordering replacement parts please be sure to quote the part number provided.

FARNELL PART NUMBER	DESCRIPTION	MANF PART NO	ISS	QTY	COMPONENT REFERENCE
31PSD	PSD3510A CASING			1.00000	
7SU5271	COVER.....	1SUWF5271		1.00000	
8L0314	INSTRUMENTS SERIAL NO LABEL	4SQ0314		1.00000	
FF12A010	FUSE 12 AMP QUICK BLOW	TDC10		2.00000	SPARES
FT4A00S503	FUSE 4 AMP ANTI-SURGE	S503		1.00000	SPARES
HA04517	WHITE HANDLE	3SU004517		1.00000	
HC22V2	PLUG & LEAD 22/V/2	22-V-2		1.00000	
HM0108	HANDLE RETAINER MOULDING	3SV0108		1.00000	

FARNELL PART NUMBER	DESCRIPTION	MANF PART NO	ISS	QTY	COMPONENT REFERENCE
HR0514	L30 HANDLE RET	ASUAE0514		2.00000	
JP4	BOX NUMBER 4	84L-09260 NO.+4+FARNELL+BOX		1.00000	
JPN55	BRN MANILLA ENV 4X3 GUM FLAP	43LP		1.00000	
4NPSDCH	PSD3510 CHASSIS ASM			1.00000	
7SU5270	CHASSIS.....	1SUCB5270		1.00000	
8SS0434	PSD3510A CHASSIS SCREEN	2SZY0434		1.00000	
7SU5276	FAN DEFLECTOR.....	2SUBA5276		1.00000	
7SU5290	FAN BKT	4SUCB5290		1.00000	
7SU5334	BLANKING PLATE....	4SUBA5334		1.00000	
7SU4522	MAINS SWITCH MOUNTING BKT	4SUBA4522		1.00000	
EF4312	FAN 12VDC 119 X 32	4312		1.00000	EF201
FF12A010	FUSE 12 AMP QUICK BLOW	TDC10		2.00000	F202 3 FIT AT TEST
FH19276	FUSE HOLDER / VOLTAGE SELECTOR	CL19276		1.00000	F201
FH346RA	FUSE HOLDER 1/4 X 1 1/4" P/MTG	U0345RAAAB		2.00000	F202 3
FT4A00S503	FUSE 4 AMP ANTI-SURGE	S503		1.00000	F201 FIT AT TEST
HFSTD	FOOT 103-E119700	103-E1197-00		4.00000	
HL70X210	PROTECTIVE FILM 70 X 210	164+TRANS-POLYTHENE		1.00000	
HL9X30	BLANK 9X30 P120	P120		1.00000	
HM0103	LENS MOULDING "P"SERIES	2SV0103		1.00000	
HL70X210	PROTECTIVE FILM 70 X 210	164+TRANS-POLYTHENE		1.00000	
SB5040	MAINS SWITCH 4 WAY	PBMS5040		1.00000	SW201
TB5938	TERMINAL BLOCK 6BA 8 WAY	R44/79/593/8P		1.00000	S202
4NPSDFP	PSD3510A FRONT PANEL ASM			1.00000	
4SPLCD	P SERIES DISPLAY ASM			1.00000	
5SPLCD	LCD METER CB ASM. P' SERIES			1.00000	5
5UPLCD	LCD METER CB ASM. P' SERIES			1.00000	
PAOMIT	POTENTIOMETERS OMITTED	PAOMIT		1.00000	P1
RAOMIT	RESISTORS OMITTED	RAOMIT		1.00000	R7
UBC1523	LCD METER PCB P' SERIES	1N1SBM15230		1.00000	
UCC4220KA0KC	2N2F 10% 50V 1206 COG	1206A222JXAT 1206J0500222KC/C09 GRM426C0G222K50PT		3.00000	C1-3
UCC5220KA0KX	22NF 10% 50V 1206 X7R	1206Y223KXAT 1206J0500223KX/C09 GRM		1.00000	C7
UCC6100KA0KX	0U1F 10% 50V 1206 X7R	1206Y104KXAT 1206J0500104KX/C09 GRM426X7R104K50PT		4.00000	C4-6
UIDP44013BT	4013BT SO-14	HEF4013BT+S014 HCF4013BM1		1.00000	U2
UIDP44051	SMD IC 4051 SO PACKAGE	HEF4051BT		1.00000	U3
UIDPF7225	INT CCT 52PIN FLAT PACK	UPD7225G00		1.00000	U1
URM00A0	LINK 1206	RC01 5MM		5.00000	LK1-5
URM5100GA0	10KR 2% 1206	RC-01 CR1206 DC2		2.00000	R6 8
URM5330GA0	33KR 2% 1206	RC-01 CR1206		1.00000	R12

FARNELL PART NUMBER	DESCRIPTION	MANF PART NO	ISS	QTY	COMPONENT REFERENCE
URM5680GA0	68KR 2% 1206	RC-01 CR1206 DC2		1.00000	R10
URM6100GA0	100K 2% 1206	RC-01 CR1206		6.00000	R2-5 9:11
URM6180GA0	180K 2% 1206	RC-01 CR1206 DC2		1.00000	R1
8P1054801	P SERIES STD LCD DISPLAY CB			1.00000	
LD17162	LCD LPH1716-2 2SC0267	LPH1716-2 2SC0267		1.00000	LD1
MF4601	DIFFUSER "P"SERIES	4SU004601		1.00000	
APS206	GREEN FILTER 254 X 381	LV206+254X381		0.05000	
SBSKH	PUSH BUTTON SWITCH SKH	SKH-HAK		2.00000	SW1 2
TBS2508H	8WAY HOUSING SMD	SEP11989-08		1.00000	S1
BC1531	LCD CONTROL "P" SERIES	1N1RBT15310		1.00000	B
CC222P0LG	22PF 2% 100V N150 RP050	683+34229		2.00000	C6:19
CEB33U0EM1	33UF 20% 16V FC +5MM	SMVB		1.00000	C17
CEC220UGM	220UF 20% 25V R050	KMVB		1.00000	C1
CR41N00LM	1.0NF 20% 100V R050	FKS2		1.00000	C20
CR510N0LM	10NF 20% 100V R050	FKS2MIN		8.00000	C7-14
CR6100NKM	100NF 20% 63V R050	MKS2MIN		6.00000	C2 3 5:15 6 8
CRA1U00KM1	1.0UF 20% 63V R050	MKS2		3.00000	C4:21 2
DG4148	DIODE	1N4148		8.00000	D1-8
DZ12V45C1	2.45 1.43% 0W30	ZN458B		1.00000	Z1
DZ15V10E	5.1V 5% 0W50	ZPD5.1		4.00000	Z2-5
FH102071	FUSE HOLDER CLIP 6.3MM PCB MTG	102071		4.00000	LP1 2
HC0221	"P" SERIES CABLE ASSY 4SC0221	2-345295-2		1.00000	S2
LF12V025	BULB 12V 0.25A 1.25 X 0.25	LF12V025		2.00000	LP1 2
PAOMIT	POTENTIOMETERS OMITTED	PAOMIT		2.00000	P1 2
RAOMIT	RESISTORS OMITTED	RAOMIT		2.00000	R5:12
RM212R0FF	12R0 1% 0W60 50PPM 250V	MRS25		4.00000	R16-19
RM3560RFF	560R 1% 0W60 50PPM 250V	MRS25		1.00000	R15
RM41K00FF	1K00 1% 0W60 50PPM 250V	MRS25		1.00000	R10
RM41K80FF	1K80 1% 0W60 50PPM 250V	MRS25 SMA0207TK50		1.00000	R13
RM43K30FF	3K30 1% 0W60 50PPM 250V	MRS25		1.00000	R21
RM48K20FF	8K20 1% 0W60 50PPM 250V	MRS25		1.00000	R20
RM510K0FF	10K0 1% 0W60 50PPM 250V	MRS25		4.00000	R1 2 4:11
RM520K0FF	20K0 1% 0W60 50PPM 250V	MRS25		1.00000	R14
TBS2508P	8WAY PIN HEADER 2.54	TSW108-18-T-S		1.00000	S3
VA3140E	IC CA3140E	CA3140E	STATIC	1.00000	U3
VA3240E	IC CA3240E	CA3240E	STATIC	1.00000	U4
VA79L05ACZ	IC LM79L05ACZ	LM79L05ACZ		1.00000	U8
VD27C25620	IC 27C256-20N	27C256-20N	STATIC	1.00000	U7
VD4052B	IC CD4052B	CD4052B CD4052BE	STATIC	1.00000	U5
VD4053B	IC CD4053BCN	CD4053BCN	STATIC	1.00000	U2
VD74HC373	IC TC74HC373P	74HC373P 74HC373	STATIC	1.00000	U6
VD80C31	IC PCF80C31BH-3-12P	PCF80C31BH-3-12P	STATIC	1.00000	U1

FARNELL PART NUMBER	DESCRIPTION	MANF PART NO	ISS	QTY	COMPONENT REFERENCE
VS16L	IC SKT 16WAY	703-3316-01-04-10		2.00000	U2 5
		ICO-163-S8A-T			
VS28C	28W CARRIER 612-92-628	612-92-628		1.00000	U7
VS40L	IC SKT 40 WAY	703-3340-03-04-10		1.00000	U1
		ICO-406-S8A-T			
VS8P	IC SKT 8WAY	703-3308-01-04-10		2.00000	U3 4
		ICO-083-S8A-T			
VX12M18U	CRYSTAL 12MH HC18-U	HC18-U		1.00000	VX1
MF4556	LIGHT REFLECTOR	4SU004556		1.00000	
RM510K0FF	10K0 1% 0W60 50PPM 250V	MRS25		3.00000	R90-2
BC1734	MAIN BOARD	BC17340		1.00000	B
DG29150	DIODE	BYW29-150		1.00000	D5
		RUR815			
DG4003	DIODE	1N4003		1.00000	D24
DG4148	DIODE	1N4148		23.00000	D3 4 6-23 5-7
DZ13V30E	3.3V 5% 0W50	ZPD3.3		1.00000	Z5
DZ14V70E	4.7V 5% 0W50	ZPD4.7		1.00000	Z7
DZ16V20D1	6.2V 0W40	1N823		2.00000	Z2 4
DZ18V20E	8.2V 5% 0W50	ZPD8.2		1.00000	Z6
RAOMIT	RESISTORS OMITTED	RAOMIT		1.00000	R41
RM11R00FF	1R00 1% 0W60 100PPM 250V	MRS25		1.00000	R15
RM210R0FF	10R0 1% 0W60 50PPM 250V	MRS25		6.00000	R16: 6-8:64 5
RM222R0FF	22R0 1% 0W60 50PPM 250V	MRS25		1.00000	R66
RM3100RFF	100R 1% 0W60 50PPM 250V	MRS25		1.00000	R5
RM3470RFF	470R 1% 0W60 50PPM 250V	MRS25		2.00000	R39
RM3560RFF	560R 1% 0W60 50PPM 250V	MRS25		2.00000	R30:93
RM3750RFF	750R 1% 0W60 50PPM 250V	MRS25		1.00000	R73
RM3820RFF	820R 1% 0W60 50PPM 250V	MRS25		1.00000	R89
RM3910RFF	910R 1% 0W60 50PPM 250V	MRS25		2.00000	R28 9
		SMA207TK50			
RM41K60FF	1K60 1% 0W60 50PPM 250V	MRS25		1.00000	R54
RM42K20FF	2K20 1% 0W60 50PPM 250V	MRS25		6.00000	R19:25:49:50 2 5
RM43K30FF	3K30 1% 0W60 50PPM 250V	MRS25		1.00000	R74
RM43K90FF	3K90 1% 0W60 50PPM 250V	MRS25		2.00000	R40:67
		SMA0207TK50			
RM44K30FF	4K30 1% 0W60 50PPM 250V	MRS25		1.00000	R11
RM44K70FF	4K70 1% 0W60 50PPM 250V	MRS25		1.00000	R13
RM45K10FF	5K10 1% 0W60 50PPM 250V	MRS25		6.00000	R8 9:37 8:42:84
		SMA0207TK50			
RM48K20FF	8K20 1% 0W60 50PPM 250V	MRS25		3.00000	R27:61 2
RM49K10FF	9K10 1% 0W60 50PPM 250V	MRS25		1.00000	R12
		SMA0207TK50			
RM510K0FF	10K0 1% 0W60 50PPM 250V	MRS25		25.00000	R1-4:18:20-4 6:44 6-8:51 3 9:63:81 2
RM515K0FF	15K0 1% 0W60 50PPM 250V	MRS25		1.00000	R10
RM530K0FF	30K0 1% 0W60 50PPM 250V	MRS25		1.00000	R43
		SMA0207TK50			
RM533K0FF	33K0 1% 0W60 50PPM 250V	MRS25		2.00000	R79:80
RM539K0FF	39K0 1% 0W60 50PPM 250V	MRS25		1.00000	R60
		SMA0207TK50			
RM547K0FF	47K0 1% 0W60 50PPM 250V	MRS25		1.00000	R70

FARNELL PART NUMBER	DESCRIPTION	MANF PART NO	ISS	QTY	COMPONENT REFERENCE
RM551K0FF	51K0 1% 0W60 50PPM 250V	MRS25		3.00000	R71:85 6
RM6100KFF	100K 1% 0W60 50PPM 250V	MRS25		7.00000	R17:31 2:68:75:83 8
RM6150KFF	150K 1% 0W60 50PPM 250V	MRS25		1.00000	R69
RM6200KFF	200K 1% 0W60 50PPM 250V	MRS25 SMA0207TK50		1.00000	R45
RM6330KFF	330K 1% 0W60 50PPM 250V	MRS25		1.00000	R87
RM6360KFF	360K 1% 0W60 50PPM 250V	MRS25		1.00000	R76
RM71M00FF	1M00 1% 0W60 50PPM 250V	MRS25		4.00000	R77 8:94 5
CEA2U20JM	2.2UF 20% 50V AXIAL	SMT		1.00000	C12
CEC100UGM	100UF 20% 25V R035	KMVB		2.00000	C4 6
CEC220UJM	220UF 20% 50V R050	KMVB		1.00000	C1
CEC470UGM	470UF 20% 25V R050	KMVB		2.00000	C3:14
CED1M00JQ	1.0MF 30% 50V R075	KMVB		2.00000	C8 9
CR41N00LM	1.0NF 20% 100V R050	FKS2		3.00000	C11 8:28
CR42N20LM	2.2NF 20% 100V R050	FKS2MIN		1.00000	C13
CR44N70LM	4.7NF 20% 100V R050	FKS2		1.00000	C32
CR510N0LM	10NF 20% 100V R050	FKS2MIN		3.00000	C21 2 7:33 5
CR533N0KM	33NF 20% 63V R050	MKS2		2.00000	C10:29
CR6100NKM	100NF 20% 63V R050	MKS2MIN		5.00000	C15-7:25 6:31 4
CR6100NPK	100NF 10% 250V	MKT-B32521-B31-4-K		2.00000	C2:23
CR6220NKK	220NF 10% 63V R050	MKS2		1.00000	C30
CRA1U00KM1	1.0UF 20% 63V R050	MKS2		3.00000	C5 7:24
DBW02M	BRIDGE RECTIFIER	W02G		1.00000	BR2 MC1 X1/L
DZ12V45C1	2.45 1.43% 0W30	ZN458B		1.00000	Z3 FIT ON VP1A PAD
DZ239V0H	39V 5% 1W30	BZV85-C39		1.00000	Z1
MC1	CERAMIC BEAD SMALL	IPB/1		6.00000	BR2 R7
PM3500RKV	500R 10% PRESET VERT STURN	63P		2.00000	P6 7
PM41K00KV	1K00 10% PRESET VERT STURN	63P		2.00000	P4 5
PM45K00KH	5K00 10% PRESET HORZ MTURN	43P		1.00000	P3
RM44K00BB	4K00 0.1% 0W25 25PPM 250V	H8		2.00000	R34 5
RM580K0BB	80K0 0.1% 0W25 50PPM 250V	H8		2.00000	R33 6
RW227R0LGR	27R0 2% 4W00	292-1		1.00000	R14
RW41K00JJ	1K00 5% 2W50	74ER		1.00000	R7 MC1 X1/L
TM115	0.25" FASTON TAB	03866+A/M/S		9.00000	X1-9
VA072CP	IC TL072CP STATIC	TL072CP		1.00000	U10
VA3240E	IC CA3240E STATIC	CA3240E		1.00000	U11
VA339N	INT CCT LM339N/CA339E	LM339N CA339E		2.00000	U7 9
VA400FY	OP AMP OP400FY	OP400FY		1.00000	U8
VA4960	2.5A SWITCHING REGULATOR	L4960		1.00000	U3
VD4011BE	IC CD4011BE STATIC	CD4011BE		1.00000	U6
VP1A	TRANSISTOR PAD TW1A	NW1802		1.00000	Z3
VS14L	IC SKT 14WAY	703-3314-01-04-10 ICO-143-S8A-T		2.00000	U6 9
VS16L	IC SKT 16WAY	703-3316-01-04-10 ICO-163-S8A-T		1.00000	U5
VS8P	IC SKT 8WAY	703-3308-01-04-10 ICO-083-S8A-T		2.00000	U10 1
VT182PK	TRANS BC182PK TO5 JOG	BC182PK		3.00000	Q3 8:11
VT212PKCR	BC212PK TO5 JOG/CROP	BC212PK35		5.00000	Q4-7:12
VTX451K	ZTX451 60V 1A TO92 N	ZTX451+(4SC0174)		1.00000	Q10

FARNELL PART NUMBER	DESCRIPTION	MANF PART NO	ISS	QTY	COMPONENT REFERENCE
VTX551K	ZTX551 60V 1A TO92 P	ZTX551K+(4SC0174)		1.00000	Q1
7SU5272	CB BRACKET	3SUCB5272		1.00000	
7SU5281	C.B HEATSINK	2SUBA5281		1.00000	
CAOMIT	CAPACITORS OMITTED			2.00000	C19:20
DBP02	BRIDGE RECTIFIER	KBP02		1.00000	BR1
DGD810	DOUBLE DIODE	BYV32-100		2.00000	D1 2
		RURD810			
DS126B	S.C.R.	TIC126B		1.00000	SCR1
PW0243	5KOR 5% LIN M/TURN	4SC0243		2.00000	P1 2
RWOR025NF	OR025 1% 10WO	4LPW10-025-1%		1.00000	R6 SEE PS
SB0059	AP PUSH BUTTON SWITCH	3STO00059		1.00000	SW2
SB0093	PUSH BUTTON (4ST0093)	F6UEE(4ST0093)		1.00000	SW1
SRG2E	RELAY G2E 24V	G2E+182P-M+24V		1.00000	RL1
TBA2510PD	PIN HEADER DOUBLE ROW 5 WAY	826925-5		1.00000	S6
TBA2512PD	PIN HEADER DOUBLE ROW 6 WAY	826925-6		1.00000	S5
TBA3902PSS	2W PIN WAFER FRICTION LOCK SQU	640445-2		2.00000	S1
TBA3903PSS	3W PIN WAFER FRICTION LOCK SQU	640445-3		1.00000	S9
TBA3904PSS	4W PIN WAFER FRICTION LOCK SQU	640445-4		2.00000	S7 8
TBM2504PS	STRAIGHT PIN HEADER 4 WAY 2.54	6410+22-27-2041		1.00000	S2
TBM2508PS	STRAIGHT PIN HEADER 8 WAY 2.54	6410+22-27-2081		1.00000	S3
TK12150796	16 WAY IDC SOCKET	1-215079-6		1.00000	S4
VA7812CT	IC 7812CT	LM340T12		2.00000	U1 4
VA7912CT	IC LM7912CT	LM7912CT		1.00000	U2
VD4053B	IC CD4053BCN	CD4053BCN	STATIC	1.00000	U5
VT3055T	TRANS MJE3055T	MJE3055T		2.00000	Q2 9
ZZ9E30240	PSD3510A CHOKE	ZZ9E30240		1.00000	L1
ZBEF20	EF20 FULL PIN 70032 A3XG5	09930		1.00000	
ZFE20G05	CORE B66311-G500-X127	B66311-G500-X127	K	1.00000	
ZFEF20	FER CORE 3218036	32-180-36	K	1.00000	
7SM0107	SINGLE BEZEL SCREENED	3SZY0432		1.00000	
7SU0002	TERMINAL LINK	4SUCJ0002		2.00000	
8ST0377	P-SERIES BEZEL SCREEN	3SZY0377		1.00000	
8ST0432	PSD3510A BEZEL SCREEN	3SZY0432		1.00000	
CEB47U0IT	47UF 50% 40V	031-37479	AXIAL	1.00000	C204
CR6470NPK1	470NF 10% 250V	368-45474	R225	1.00000	C203
HM0107	SINGLE FRONT BEZEL	2SV0107		1.00000	
HK0246	"P" SERIES KNOB BEIGE	4SC0246		2.00000	
HK0248	"P" SERIES KNOB CAP BEIGE	4SC0248		1.00000	
HM0100	FRONT MOULDING "P"SERIES	1SV0100		1.00000	
HM0101	BUTTON "P"SERIES	3SV0101		2.00000	
HM0102	BLANKING STRIP "P"SERIES	3SV0102		1.00000	
SA0249	SWITH BUTTON "P" SERIES	4SC0249		3.00000	
TC1418782	FASTON TAB .25" DOUBLE	141878-2		4.00000	
TM2BLK	TERMINAL BLACK	TP2+(BLK)		2.00000	
TM2EGRN	TERMINAL GREEN	TP2E+(GREEN)		1.00000	
TM2RED	TERMINAL RED	TP2+(RED)		2.00000	
4NPSDHS	PSD3510A HEATSINK ASM			4.00000	
7SU5277	HEATSINK BKT	1SUBA5277		1.00000	
7SU5278	HEATSINK SUPPORT	3SUBA5278		1.00000	
7SU5333	BUS BAR	4SUCJ5333		3.00000	

7SX5282	MAIN HEATSINK	3SUDJ5282		4.00000	
FARNELL PART NUMBER	DESCRIPTION	MANF PART NO	ISS	QTY	COMPONENT REFERENCE
BC1748	PSD3510A TRANS BOARD	BC17480		1.00000	
RW0R500JJ	0R50 5% 2W50	74ER		3.00000	R201-3
SR080P08	THERMAL TRIP 80C N/O	P08-080-05		1.00000	TH202
SR100P06	THERMAL TRIP 100C N/C	P06-100-05		1.00000	TH204
VT3055S	SEMELAB COMP ONLY	2N3055H		3.00000	Q201-3
4NPSDTR	PSD3510 TRANSFORMER ASM			1.00000	
7SF5279	TRANSFORMER SPACER	4SU005279		1.00000	
7SU5274	TRANSFORMER BKT	2SUBA5274		1.00000	
7SU5275	TRANSFORMER SUPPORT	3SUBA5275		1.00000	
7SU0418	CAP BRACKET	3SUDA0418		2.00000	
CEE33M0LT	33MF 50% 80V	ALS29A1052PJ/3SC0279		1.00000	C202
CRA1U00LK	1.0UF 10% 100V R150	373-21105		1.00000	C201
DBC2506	BRIGE RECT UL REF E54214/QQFU2	KBPC2506/GBPC2506		1.00000	BR201
TK192710	IEC INLET SOCKET	CL192710		1.00000	S201
ZR0344	MAINS TORROID PSD3510A	2SR0344		1.00000	TX201
6P10107	PSD3510A WIRE PREP			1.00000	
7SB5273	PUSH ROD	4SUCB5273		1.00000	
7SU5280	HANDLE SUPPORT	2SUCB5280		1.00000	
7SU5284	L&R HAND SUPPORT	3SUCB5284		2.00000	
HMDEC06	FILTER FOAM DECLON 6mm THICK	10PPI+(6MM+THICK)		0.30000	
TV19285	IEC INLET SHROUD	CL19285		1.00000	S201

INCORPORATING WAYNE KERR INSTRUMENTS

MP MASTER

MA23427